

# GeoScience Abstracts

3-2480 TO 3-2857

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**AMERICAN GEOLOGICAL INSTITUTE**



## GEOSCIENCE ABSTRACTS

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# GeoScience Abstracts

## 1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

### PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-2495, 3-2496, 3-2497, 3-2499, 3-2501, 3-2502, 3-2503, 3-2506 through 3-2511; Geomorphology 3-2520; Stratigraphy 3-2559, 3-2571; Geohydrology 3-2748, 3-2758; Engineering Geology 3-2834.

3-2480. Ontario, Dept. of Mines. TISDALE TOWNSHIP, SOUTHWEST QUARTER, SUBSURFACE NO. 1: Its: Prelim. Map P.106, scale 1 in. to 500 ft., 1961.

The first in a series of 7 preliminary subsurface geological maps (see abstracts below) on the S. half of Tisdale Township, District of Cochrane. The maps have been prepared by the Ontario Dept. of Mines in cooperation with the producing mines and past producers of this part of the Porcupine area. Geology was compiled by S. A. Ferguson of the department's staff, from plans supplied by mining companies. Producing mines in the area are Holtinger, Moneta, Mace (Vipond), Consolidated Gillies Lake, and Fuller (Nakhodas option). Accompanying the maps are a legend sheet (unnumbered) and a stratigraphic correlation table of 7 subsurface sections of the Tisdale group lavas, compiled by R. M. Ginn (Prelim. Map P.113).--A.C. Sangree.

3-2481. Ontario, Dept. of Mines. TISDALE TOWNSHIP, SOUTHWEST QUARTER, SUBSURFACE NO. 2: Its: Prelim. Map P.107, scale 1 in. to 500 ft., 1961.

3-2482. Ontario, Dept. of Mines. TISDALE TOWNSHIP, SOUTHWEST QUARTER, SUBSURFACE NO. 3: Its: Prelim. Map P.108, scale 1 in. to 500 ft., 1961.

3-2483. Ontario, Dept. of Mines. TISDALE TOWNSHIP, SOUTHEAST QUARTER, SUBSURFACE NO. 1: Its: Prelim. Map P.109, scale 1 in. to 500 ft., 1961.

3-2484. Ontario, Dept. of Mines. TISDALE TOWNSHIP, SOUTHEAST QUARTER, SUBSURFACE NO. 2: Its: Prelim. Map P.110, scale 1 in. to 500 ft., 1961.

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3-2486. Ontario, Dept. of Mines. TISDALE TOWNSHIP, PART OF SOUTH HALF, SUBSURFACE NO. 4: Its: Prelim. Map P.112, scale 1 in. to 500 ft., 1961.

3-2487. Ontario, Dept. of Mines. PORT COLDWELL AREA, DISTRICT OF THUNDER BAY: Its: Prelim. Map P.114, scale 1 in. to 1/2 mi., 1961.

3-2488. Ontario, Dept. of Mines. PARTS OF TOWNSHIPS 167 & 168, DISTRICT OF ALGOMA, ONTARIO: Its: Prelim. Map P.115, scale 1 in. to 1/4 mi., 1961.

3-2489. Creasey, S.C., and others. RECONNAISSANCE GEOLOGIC MAP OF PARTS OF THE SAN PE-

DRO AND ARAVAIPA VALLEYS, SOUTH-CENTRAL ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-238, scale 1:125,000, contour interval 200 ft., lat. 32°15'-33°15'N., long. 110°-111°W., 1961.

3-2490. Munger Map Book. CALIFORNIA-ALASKA OIL AND GAS FIELDS: 5th ed., 215 p., 5865 West Boulevard, Los Angeles 43, California, Apr. 1961.

Maps are primarily of California, but include 4 fields on Kenai Peninsula, Alaska. They show uncompleted drilling, idle, and abandoned wells; completed producing, idle, and abandoned wells; water wells; abandoned converted to water; gas and gas abandoned; water disposal; water drive.--A.C. Sangree.

3-2491. Pearre, Nancy C., comp. MINERAL DEPOSITS OF MARYLAND EXCLUDING FUELS, SAND, AND GRAVEL: U.S. Geol. Survey, Mineral Inv. Map MR-12, scale 1:250,000, 1961.

This map is compiled from published material, information in the files of the U.S. Geological Survey, and field observations. It shows location of mines, quarries, placer workings, and prospects. Letter symbols identify the mineral commodities, and a numerical list, arranged by counties, supplies the name of each locality and the source of information.--U.S. Geol. Survey.

3-2492. National Petroleum Bibliography. GEOLOGICAL MAPS - OKLAHOMA OIL & GAS: 329 p., maps, P.O. Box 3586, Amarillo, Texas, 1961.

The greatest single need of information in the oil-producing industry is for evaluation purposes, whether of wells, fields, or provinces. This book is an effort to bring together in one volume the experience of Oklahoma operating firms as revealed in the public records of the Oil and Gas Division, Oklahoma Corporation Commission. The structure maps and isopachs in the volume required intensive evaluation of more than 7,000 hearing files covering the period 1955-1961. It is believed that this book will prove an important reference to the geology of Oklahoma producing areas in serving as a starting point for oil and gas evaluation. It is also hoped that it will add to the states' reserve picture by stimulating exploration on the basis of new and different interpretations of field data presented herein.--From foreword.

An index by counties is provided for the more than 300 maps in the volume.

3-2493. U.S. Geological Survey. CRATER LAKE NATIONAL PARK AND VICINITY, OREGON: scale 1:62,500, contour interval 50 ft., lat. 42°43'-43°09' N., long. 121°55'-122°20'W., 1933-1956, reprinted 1961.

3-2494. U.S. Geological Survey. WIND CAVE NATIONAL PARK AND VICINITY, SOUTH DAKOTA: scale 1:24,000, contour intervals 20 and 40 ft., lat. 43°30'-43°40'N., long. 103°17'30"-103°34'W., 1957, reprinted 1961.

### PART 2. AREAL AND REGIONAL GEOLOGY

See also: Stratigraphy 3-2548; Geohydrology 3-2748, 3-2755; Mineral Deposits 3-2781; Engineering Geology 3-2834.

3-2495. Little, H.W. NELSON MAP-AREA, WEST HALF, BRITISH COLUMBIA: Canada, Geol. Survey,



Mem. 308, 205 p., Maps 1090A and 1091A (in pocket), scale 1:253,440, correlation chart (in pocket), 20 figs. (6 in pocket), 5 pls., 3 tables, 1960, 130 refs.

Nelson map-area embraces some 3,000 sq. mi. of mountainous terrain in S.-central British Columbia. It consists of generally severely folded and faulted sedimentary and volcanic rocks representing most systems from the Windermere (late Precambrian) to the Cretaceous. Within all these are emplaced plutonic rocks, mainly acidic, of 2 distinct ages. The more abundant are the Cretaceous(?) granitic bodies of the Nelson and Valhalla plutonic rocks. These are shown to be in large part of metamorphic origin, although in places there is clear evidence of magmatic injection. The younger plutonic rocks are of Tertiary age, more alkaline in composition, and mainly of magmatic origin.

Mining has been active for many decades. The most important camps are the Rossland Au-Cu camp in the SW., the Slocan Ag-Pb camp in the NE., and the Sheep Creek Au camp in the SE. Elsewhere within the map-area other individual mines have been of importance, and small producers and prospects are numerous. Major production from the Rossland and Sheep Creek camps ended in 1928 and about 1942, respectively. In recent years most ore has been won from Zn-Pb-Ag mines in the Slocan camp and the limestone belt W. and SW. of Sheep Creek camp. In this belt the Emerald, Feeney, and Dodger mines have been the largest producers of W concentrate in Canada.--Auth.

3-2496. Barry, George S. GEOLOGY OF THE WESTERN OXFORD LAKE-CARGHILL ISLAND AREA, OXFORD LAKE MINING DIVISION: Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 59-2, 37 p., 3 maps incl. Maps 59-2A, 59-2B (in pocket), scale 1:63,360, table, 1960, 29 refs.

Volcanic and sedimentary rocks of the area form part of a greenstone belt over 60 mi. in length from Carrot River to Gods Lake. Within the map-area the belt varies in width from 10 mi. in the central part of the Carghill Island area to just over 2 mi. in the western part of the area.

The volcanic and sedimentary rocks are divided into 2 groups - the Hayes River and Oxford [Precambrian]. Three distinctive lithological series have been recognized; a predominantly effusive volcanic series (the lower unit of the Hayes River group); a pyroclastic volcanic and clastic sedimentary series (the upper unit of the Hayes River group); and an entirely clastic sedimentary series (the Oxford group).

The writer's interpretation of the geology of the area differs in one major respect from the early interpretation of Wright. The pyroclastic series is now considered a distinctive part of the upper unit of the Hayes River group whereas Wright mapped these rocks as basal conglomerates of the Oxford group.

The oldest rocks of the area consist predominantly of pillowed and massive basic to intermediate lavas with minor pyroclastic rocks, acid lavas, and graywacke forming the lower unit of the Hayes River group. These rocks underlie the area N. of Oxford Lake, part of Carghill Island, and part of the S. shore of Oxford Lake.

Pyroclastic rocks of the upper unit of the Hayes River group, which overlie conformably the older volcanic rocks, consist predominantly of volcanic breccias with tuffaceous matrix, lapilli tuffs, and tuffs. Minor lithologic types include agglomerates, flows, and tuffaceous sediments. This unit outcrops along the northern shore of Oxford Lake, the southern

shore of Carghill Island, and on adjacent islands. Traverse Island, E. of Carghill Island, is composed almost entirely of volcanic breccia and tuffs.

Sedimentary rocks of the same unit consist predominantly of graywacke, subgraywacke, dark finely banded argillite, slate, chert, and minor protoquartzite and conglomerate. These rocks outcrop on 3 major islands E. of Carrot Bay and part of the S. shore of Oxford Lake near the eastern boundary of the map-area.

The subdivision of the Hayes River group into a lower and upper unit was proposed [see *GeoScience Abstracts* 2-3152] for the Knee Lake and Oxford House areas to the E., and can be extended to the present map-area. However, it is recognized that these units are not necessarily applicable to similar belts N. and S. of the map-area.

Rocks of the Hayes River groups are separated from the overlying clastic sedimentary rocks of the Oxford group by an unconformity which is well exposed on a large island on Oxford Lake (95°45'N.). There, steeply dipping pillowed lavas facing N. are overlain by conglomerate facing E. The exposures of conglomerate are interpreted as occurring on the nose of a syncline plunging steeply to the E.

The Oxford group consists of conglomerate, arkose, subarkose, subgraywacke, graywacke, argillaceous sediments, and related schists. These rocks apparently occupy the central part of the syncline. Local structure is complicated by several extensive faults paralleling the trend of the formations. These faults are most probably responsible for the absence of the Oxford group of rocks in the W.-central part of the area and their presence on and in the vicinity of Hyers Island 10 mi. farther to the W.

Gneissic intrusive granitic rocks, ranging in composition from granodiorite to tonalite, lie S. and N. of the greenstone belt. Within the map-area the gneiss shows definite intrusive characteristics. However, eastward it passes into a band of paragneiss. There is no marked distinction between the gneisses to the S. of Oxford Lake and those exposed N. of the lake, except for the granitic rocks near Semple Lake which are only slightly gneissic and at places massive. Predominantly massive granodiorite and tonalite also occur W. of Hyers Island.

Gabbro and diorite intrude the rocks of the greenstone belt. Their age is unknown but some evidence suggests that they are older than the granitic intrusions as they are cut by pegmatitic bodies. Serpentinite occurs on several reefs near the southwestern corner of Oxford Lake. This intrusion is associated with gabbro which in turn is cut by pegmatite.

The youngest intrusions are diabase and lamprophyre dikes. They are especially numerous in the southwestern part of the map-area, and cut both the Hayes River and Oxford groups of rocks.--From *auth.*, p. 5-6.

3-2497. Jackson, G.D., BELCHER ISLANDS, NORTHWEST TERRITORIES: Canada, Geol. Survey, Paper 60-20, 13 p., Map 28-1960 (in pocket), scale 1:126,720, 1960, 7 refs.

Geology of an area in the SE. part of Hudson Bay, which includes Belcher, Bakers Dozen, and King George islands. All rocks in the area may be included in the Belcher group of clastic and chemically precipitated sedimentary rocks, and volcanic flows. These have been intruded by basic sills and dikes. No major unconformities or repetitions by faulting were observed. The Proterozoic Belcher group is di-



## GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

vided into map-units forming a total thickness of 4,000 ft. comprising mainly dolomite (sometimes with stromatolite zones), limestone and argillite. The Belcher group underlies the Cenozoic deposits of sand, silts, and gravels with an angular unconformity. Glacial evidence indicates that the ice came from the NE. Fe, in the form of hematite and magnetite, and Cu minerals are abundant in the area.--M. Stewart.

3-2498. Hoare, Joseph M. **GEOLOGY AND TECTONIC SETTING OF LOWER KUSKOKWIM-BRISTOL BAY REGION, ALASKA**: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 5, p. 594-611, 3 maps, table, May 1961, 16 refs.

The lower Kuskokwim-Bristol Bay region is an area of about 25,000 sq. mi. in SW. Alaska which includes most of the mountainous province between the Bethel lowlands on the W. and the Nushagak lowlands on the E. The region has been repeatedly subjected to strong compressive forces operating NW. and SE., and strata of Late Cretaceous age and older are severely deformed.

The rocks range in age from Precambrian to Quaternary. Except for continental volcanic rocks of Tertiary and Quaternary age, the formations were deposited under geosynclinal conditions. From oldest to youngest, the stratigraphic column consists of: 1) metamorphic rocks of Precambrian age, 2) limestone of Devonian age, 3) the Gemuk group consisting of sedimentary and volcanic rocks ranging in age from Carboniferous to Early Cretaceous, 4) andesitic volcanic rocks of Middle and Late Jurassic age, 5) the Kuskokwim group consisting of graywacke and shale of Cretaceous age, 6) continental basalt of Tertiary and Quaternary age, and 7) surficial deposits of Quaternary age.

Volcanic rocks of Jurassic age which crop out of the W. flank of the Kilbuck Mountains were, until recently, thought to be of Late Cretaceous age. The Jurassic age of these rocks indicates that they are part of the Ruby geanticline and that the Kuskokwim geosyncline probably does not extend SW. beneath the Bethel basin.

The Kuskokwim group is characterized by coarse-grained clastic rocks which were derived from local geanticlinal uplifts and deposited in the Kuskokwim geosyncline. Several lines of evidence show that these rocks were deposited rapidly and constitute an unsorted "poured-in" sediment of low porosity.

Major structural elements of the region are the Ruby geanticline, Kuskokwim geosyncline, and Goodnews arch which were formed in Middle to Late Jurassic time. During Late Cretaceous and early Tertiary time the rocks were folded and faulted and intruded by igneous rocks of several kinds.--Auth.

3-2499. Wells, John D. **STRATIGRAPHY AND STRUCTURE OF THE HOUSE ROCK VALLEY AREA, COCONINO COUNTY, ARIZONA**: U.S. Geol. Survey, Bull. 1081-D, p. 117-158, 3 maps (2 geol. in pocket, scales 1:62,500 and 1:125,000), graphs, 1960, 27 refs.

The House Rock Valley area consists of four 7 1/2-min. quadrangles: House Rock Spring NE., House Rock Spring SE., Paria Plateau NW., and Paria Plateau SW. These quadrangles cover House Rock Valley, part of the Paria Plateau, part of the E. Kaibab monocline, and part of the Kaibab Plateau.

The bedrock in the area consists of: a) Red siltstone in the Hermit shale, gypsum in the Toroweap formation, and dolomite, limestone, and sandstone

in the Toroweap formation and Kaibab limestone, all of Permian age; b) red siltstone and sandstone in the Moenkopi and Chinle formations of Triassic age and in the Moenave formation of Triassic(?) age, gray and red mudstone in the Chinle formation, and conglomeratic sandstone in the Shinarump member of the Chinle formation; c) red sandstone and siltstone in the Kayenta formation of Jurassic(?) age and in the Carmel formation of Jurassic age, red and white eolian sandstone in the Navajo sandstone of Jurassic and Jurassic(?) age, and red limestone in the Carmel formation. The Coconino sandstone is absent. The upper part of the Navajo sandstone and lower part of the Carmel formation are intertongued. In the Chinle formation the Shinarump member is thin in the northern part of the area and absent in the southern part; the Owl Rock member is thin or absent. All other units are typical of the rocks on the Colorado Plateau.

Surficial Quaternary deposits are landslide blocks, landslide debris, sand, alluvial fans, and alluvium.

The tectonic structures in this area - folds, faults, and joints - are typical of those on the Colorado Plateau. The most prominent feature is the E. Kaibab monocline, a 130-mi.-long arcuate fold, which has the W. side upthrown 3,500 ft. Nearly parallel to the monocline are high-angle faults with offsets of several hundred feet; some have the E. side upthrown, others have the W. side upthrown. Many minor folds and faults trend nearly parallel to and diagonally to the monocline. Joints trend parallel to both the major and minor faults and folds. Some of the minor structures - shear zones and thrust faults - were formed by local compression while the high-angle faults, horsts, and grabens were formed by tension.

No ore deposits are known to exist in the area although abnormally high radioactivity and Cu minerals are present.

Small amounts of water occur at the base of the Navajo sandstone and in the unconsolidated surficial deposits.--Auth.

3-2500. Shreveport Geological Society. **GUIDE BOOK, 1961 SPRING FIELD TRIP, MARCH 24-25, 1961. CRETACEOUS OF SOUTHWEST ARKANSAS AND SOUTHEAST OKLAHOMA. SELECTED FIELD PAPERS**: 89 p., illus., maps, secs., tables, P.O. Box 750, Shreveport, Louisiana, 1961, 15 refs.

The 2-day field trip covers areas in SW. Arkansas and SE. adjacent Oklahoma in which at least 14 type localities of Mesozoic formations have been described in literature. Five of the formation outcrops studied are type localities. Of the 21 stops made during the 2 days, 2 were in outcrops of the Midway (Eocene) formation, 8 in outcrops of Upper Cretaceous, 1 is an unconformable contact of Upper Cretaceous and Lower Cretaceous. Eight stops were made to study Lower Cretaceous formations and 2 to observe Lower Cretaceous resting unconformably on Paleozoics; altogether 19 different recognizable formations were studied.

The Mesozoic-Paleozoic contact reveals a pronounced onlap within Lower Cretaceous formations from E. to W. The marked angular unconformity at the Upper Cretaceous-Lower Cretaceous contact reveals that the Lower Cretaceous formations were tilted to the SW., truncated and then overlapped by Upper Cretaceous deposits. An eastward onlap, accompanied in part by truncation and overlap, occurs in the basal Upper Cretaceous beds. Upper Cretaceous formations thin towards the E.; the Annona chalk disappears from the section E. of the line of traverse.



Facies changes are noted in many of the formations on the outcrop. A brief summation shows subsurface equivalents of surface formations - both Comanchean and Gulfian series.

Structure maps, type electrical logs, and pertinent data of 7 fields located in S. Arkansas and N. Louisiana are included in the guidebook: Sandy Bend and Winchester fields, both located in Union County, Arkansas, produce oil from the Nacatoch (Navarro) sand, and Meakin (Ozan) sand respectively. Calhoun field, located in Ouachita, Lincoln, and Jackson parishes, Louisiana, produces gas and distillate from 3 Hosston, and 7 Cotton Valley sands. The Cottage Grove field, Bossier Parish, Louisiana, produces oil from the Buchrange (Ozan) sand. The Sugar Creek field, Claiborne Parish, Louisiana, produces gas and/or oil from 7 zones of Lower Cretaceous and Jurassic formations. The Lower Cretaceous Rodessa and James limestones produce gas, the Darret zone produces both oil and gas, and the middle Hosston sandstones produce gas. The Cotton Valley sandstones, "D" sand, Bodcaw, and Vaughn sands produce gas and distillate. The Tew Lake, and Harrisonburg fields, both in Catahoula Parish, Louisiana, produce oil from the Tew Lake, Wilcox (Eocene) sand. In addition the Tew Lake field produces oil from the E-2 sand, Wilcox (Eocene), and the Harrisonburg field produces oil from the Stutson "A" sand, Wilcox (Eocene).--B.W. Blanpied.

3-2501. Byers, Frank M., Jr. GEOLOGY OF THE ALVORD MOUNTAIN QUADRANGLE, SAN BERNARDINO COUNTY, CALIFORNIA: U.S. Geol. Survey, Bull. 1089-A, p. 1-71, 4 illus., 2 maps incl. col. geol. map (in pocket), scale 1:62,500, 2 secs. (1 in pocket), 4 tables, 1960, 36 refs.

Tertiary volcanic and nonmarine sedimentary rocks of the Alvord Mountain quadrangle in the central Mojave Desert lie on a preexisting irregular topography eroded on metamorphic and igneous rocks, ranging in age from probable Precambrian to late Mesozoic. The lower 1,000 ft. of the Tertiary system consists of 3 newly named formations: the Clews fanglomerate, the Alvord Peak basalt, and the Spanish Canyon formation, which consists of tuff, arkosic sandstone, and olivine basalt. The upper 1,250 ft. of the known Tertiary is assigned to the Miocene Barstow formation. Dissected granitic fanglomerate of Pliocene and possibly Pleistocene age is in a few places conformable on the Barstow formation but in most places has an angular discordance with the Barstow of as much as 30°. Other rocks assigned to a late Tertiary and early Quaternary age are volcanic rocks of Lane Mountain, olivine basalt, volcanic gravel, and breccia and fanglomerate. The Quaternary rocks include basalt flows, landslide and talus deposits, Manix lake beds, windblown sand, alluvium, and clay and silt of the present playas.

The principal structural features include the Alvord Mountain upwarp, the Spanish Canyon anticline, the Bicycle Lake fault zone, the E.-trending Coyote Lake fault, and similar parallel faults. The SE. part of the Alvord Mountain upwarp is broken by 2 E.- to NE.-trending faults, which westward may merge under alluvium to form a southern boundary fault of Alvord Mountain.

Mineral resources include Au, W, limestone, and possibly accumulations of saline minerals in a Miocene basin S. or E. of the quadrangle.--Auth.

3-2502. Dibblee, Thomas W., Jr. GEOLOGY OF THE ROGERS LAKE AND KRAMER QUADRANGLES,

CALIFORNIA: U.S. Geol. Survey, Bull. 1089-B, p. 73-139, 4 maps incl. 3 geol. maps (in pocket), scale 1:21,680, 1:62,500, 1:500,000, chart, 1960, 19 refs.

The Rogers Lake and Kramer quadrangles cover about 490 mi. in the western Mojave Desert, California. The area covered is one of low relief with altitudes ranging from 2,271 to 3,426 ft. above sea level.

The rock units may be grouped into 3 main divisions separated by major unconformities, namely, pre-Tertiary crystalline rocks, Tertiary volcanic and sedimentary rocks, and Quaternary alluvial sediments.

The pre-Tertiary rocks are largely plutonic and of probable late Mesozoic age; they are predominantly quartz monzonite. Others are granite, hornblende diorite; these are cut by dikes of pegmatite-aplite and quartz latite. A pendant of metasedimentary rocks of late Paleozoic(?) age lies partly within the area.

Unfossiliferous nonmarine strata of Tertiary age are mapped as the Tropic group. It is about 2,600 ft. in maximum exposed thickness and is divided into 3 parts. The lower part, as thick as 1,600 ft., is a sequence of tuff, carbonates, shales, sandstones, and basalt flows. The Red Buttes quartz basalt flow, as thick as 200 ft., forms the middle part. The upper part, as thick as 800 ft., is mainly shale and sandstone.

Quaternary sediments consist of coarse granitic fanglomerate as thick as 1,000 ft. or more, and alluvium as thick as 200 ft.

Principal structural features are several broad upwarps that expose pre-Tertiary crystalline rocks partly overlain by deformed Tertiary stratified rocks, and downwarps or valley areas filled with Quaternary sediments. High-angle faults of NW. and E. trends are mapped.--Auth.

3-2503. MacDonald, Gordon A., and others. GEOLOGY AND GROUND-WATER RESOURCES OF THE ISLAND OF KAUAI, HAWAII: Hawaii, Div. Hydrography, Bull. 13, 212 p., 38 figs., 10 pls. (2 in pocket incl. col. geol. map, scale 1:62,500), tables, 1960, 72 refs.

Kauai is one of the oldest, and is structurally the most complicated, of the Hawaiian Islands. Like the others, it consists principally of a huge shield volcano, built up from the sea floor by many thousands of thin flows of basaltic lava. The volume of the Kauai shield was on the order of 1,000 cu. mi. Through much of its growth it must have resembled rather closely the presently active shield volcano Mauna Loa, on the island of Hawaii. It is believed that Kauai volcano started late in the Tertiary period, possibly early or middle Pliocene. Growth of the shield was rapid and probably was completed before the end of the Pliocene.

Toward the end of the growth of the shield, its summit collapsed to form a broad caldera, the boundaries of which were rather indefinite. The principal depression was bordered by less depressed fault blocks, some of which merged imperceptibly with the outer slopes of the volcano. Elsewhere the caldera rim was low, and flows spilled over it onto the outer slopes. The well-defined central depression of the Kauai caldera was approximately 10 to 12 mi. across.

At about the same time as the formation of the major caldera, another, smaller caldera was formed by collapse around a minor eruptive center on the



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southeastern side of the Kauai shield. Lavas accumulated in the calderas. The caldera-filling lavas differed from those that built the major portion of the shield in being much thicker and more massive as a result of ponding in the depressions. The petrographic types for the most part are the same throughout. Both the flank flows that built most of the shield and the flows that filled the calderas are predominantly olivine basalt. Picrite-basalt (oceanite) and basalt are present but together compose less than 10% of the whole. Late in the period of filling of the major caldera a small amount of basaltic andesine andesite was extruded.

Near the end of the period of filling of the major caldera further collapse occurred, forming a large graben on the southwestern side of the shield. Lava flows erupting within the caldera poured southwestward over the cliff bounding the graben and spread over the gently sloping graben floor. Near the present Waimea Canyon their advance was obstructed by the fault scarp at the W. edge of the graben. The cliff along the NE. edge of the graben eventually was buried by lava flows from within the caldera, but that along the W. edge continued to stand above the level of the flows in the graben. The flows that accumulated in the graben are of the same types as those that filled the caldera, and like them are mostly thick and massive.

The rocks of the major Kauai shield volcano are known as the Waimea Canyon volcanic series. The thin flows that accumulated on the flanks of the shield, which compose the major portion of the volcanic edifice, are named the Napali formation. The rocks that accumulated in the big summit caldera are named the Olokele formation, and those that filled the small caldera on the SE. flank of the shield are named the Haupu formation. The volcanic rocks accumulated in the graben on the southwestern side of the shield are named the Makaweli formation, and sedimentary rocks interbedded with them are known as the Mokuone member of the Makaweli formation.

Few vents of the Waimea Canyon volcanic series have been recognized, probably because most of them have been destroyed by erosion or are buried by later lavas. Large numbers of dikes cut the lavas of the Napali formation along Waimea Canyon and the Napali Coast and along the E. edge of the Waialeale massif. Fewer dikes are found in the other members of the series. Some tendency toward radial arrangement of the dikes is present, but the dominant trend all over the island is ENE.

Another great collapse took place on the eastern flank of the volcano at about the time the major shield became extinct, or shortly afterward. A sub-circular graben 6 or 7 mi. across sank several thousand feet, forming a broad depression between the Waialeale massif on the W. and Kalepa and Nonou ridges on the E. This collapsed structure cannot be as clearly demonstrated as the Makaweli graben on the SW. side of the shield, because its walls have been greatly eroded and its floor is deeply buried by lavas of the later Koloa volcanic series. It appears, however, to be the only reasonable explanation of the physiography of the eastern side of the island.

After the completion of the great Kauai shield came a long period of erosion during which no volcanic activity occurred. Waves cut high sea cliffs around the island, and streams cut canyons as much as 3,000 ft. deep. Thick soil formed over much of the mountain.

Then volcanism was renewed. Eruption occurred from a series of minor vents arranged in nearly N.-S. and NE.-SW. lines across the eastern two-thirds

of the island. The lavas, cinder cones, and ash beds of this period of volcanism are known as the Koloa volcanic series. Lavas of the Koloa volcanic series include olivine basalt, picrite-basalt (mimosite) with few phenocrysts of olivine, basanite, nepheline basalt, melilite-nepheline basalt, and ankaratrite (nepheline basalt very rich in pyroxene and olivine). Inclusions of dunite, composed almost entirely of olivine, are common in flows of the Koloa. Just before and during the eruption of the Koloa volcanic series, voluminous landslides and mudflows brought down a large amount of rock debris and soil from the steep slopes of the mountainous central upland and deposited it as breccias at the foot of the steep slopes in valley heads and along the border of the marginal lowland. Streams distributed part of the material across the lowland. The breccias and conglomerates thus formed, and later buried by lavas of the Koloa volcanic series, are named the Palikea formation of the Koloa volcanic series.

The structures formed at Koloa vents include cinder cones, one tuff cone, and lava cones. The latter are miniature shields resembling the major shield volcano, formed by repeated outpourings of fluid lava. The tuff cone, at the W. side of Kilauea Bay, was formed by phreatomagmatic explosions caused by rising magma coming in contact with water-saturated rocks.

Volcanism during Koloa time continued for a long period but was not continuous over the entire area. Locally, long periods of quiet occurred, allowing streams to re-excavate some of the canyons filled by earlier flows of the Koloa volcanic series, and weathering to form soils later buried by new flows. Some of the canyons thus formed during the time when the Koloa was being deposited were several hundred feet deep. Volcanism probably continued throughout most of the Pleistocene. The latest flow of the Koloa volcanic series appears very recent, and rests on lithified calcareous dunes formed during one of the Pleistocene low stands of the sea.

During the Pleistocene stream valleys and sea cliffs were eroded to base levels governed by one or more stands of the sea more than 100 ft. below present sea level. Beaches of calcareous sand were formed and the sand blown inland to form calcareous dunes, now lithified. A test boring near Moloaa penetrated calcareous sand 160 ft. below sea level, at the foot of a high sea cliff. Coral reef also was built around part or all of the island, and in part buried by lavas of the Koloa volcanic series. The explosions that built the tuff cone at Kilauea Bay threw up fragments of limestone from a buried reef. Much of the apron of lavas of the Koloa series around the northeastern side of the island probably rests on a platform formed below present sea level by wave erosion and the growth of coral reef.

As the sea rose around the island, the valley mouths were alluviated. Several levels of the sea higher than the present one probably are represented. Some stream terraces may be graded to a stand of the sea as high as 260 ft. above present sea level, but no positive evidence for stands higher than 25 ft. have been found. Well-preserved shorelines are recognized approximately 25 and 5 ft. above sea level. Much of the present coral reef appears to have been formed when the sea stood about 5 ft. higher than now, and reduced to its present level by solutional weathering and wave erosion.

The lavas of the Napali formation of the Waimea Canyon volcanic series are highly permeable. They carry basal water over much of the island and yield it freely to wells. This water is fresh everywhere except very close to the coast on the leeward side

of the island. In some areas they may contain water confined at high levels between dikes. The lavas of the Olokele and Haupu formations are moderately to poorly permeable. They probably contain fresh water at sea level, but would not yield it readily to wells. Locally, ash beds perch small bodies of fresh water at high levels in the lavas of the Olokele formation, but these are of no economic importance. The lavas of the Makaweli formation also are moderately to poorly permeable. They carry fresh or brackish water at sea level. In general, they yield water to wells less readily than the lavas of the Napali formation, but more readily than the lavas of the Olokele. The conglomerates and breccias of the Mokuone member are poorly permeable, but are not known to perch more than a slight amount of water in the overlying lavas.

The lava flows of the Koloa volcanic series are poorly to moderately permeable. They carry fresh or brackish water at sea level, but generally yield it slowly to wells. Locally, small bodies of fresh water are perched at high levels in the lavas of the Koloa by beds of ash and soil and by breccia and conglomerate of the Palikea formation.

Both the older and the younger alluvium generally are poorly permeable, but contain small amounts of fresh or brackish water. The lithified calcareous dunes are permeable, but they appear to contain only brackish water. Lagoon deposits on the Mana plain are poorly to moderately permeable and yield brackish water to wells.--From auth.

3-2504. Schwarze, David Martin. GEOLOGY OF THE LAVA HOT SPRINGS AREA, IDAHO: Idaho State College Mus., Occasional Papers, no. 4, 51 p., geol. map (separate), 6 figs. incl. maps, sec., chart, 1960, 38 refs.

The area of this report includes part of the Portneuf Range and the Fish Creek Range, in southeastern Idaho. Paleozoic rocks consist of about 8,000 ft. of limestone, dolomite, shale, and quartzite, comprising from oldest to youngest: Blacksmith formation, Bloomington formation, Nounan formation, St. Charles formation, Garden City formation, Swan Peak formation, Fish Haven dolomite, and Laketown dolomite. Unconformably overlying the Paleozoic rocks are volcanic ash and conglomerate of the Tertiary Salt Lake formation. Igneous rocks consist of a basalt flow of Pliocene age interbedded with the Salt Lake formation, and a basalt flow of Pleistocene age that occupies part of the Portneuf Valley.

Aside from widespread uplift, the Laramide orogeny had little effect on the rocks of the Lava Hot Springs area. Most of the uplift and the tilting of the Paleozoic and Tertiary formations is attributed to block faulting in Pliocene time.

Outlook for economic mineral development is not favorable in the Lava Hot Springs area.--Auth.

3-2505. Gray, Henry H., and others. GEOLOGY OF THE HURON AREA, SOUTH-CENTRAL INDIANA: Indiana Geol. Survey, Bull. no. 20, 78 p., 4 figs., 3 pls., 7 tables, 1960.

The Huron area is approximately 85 mi. SSW. of Indianapolis and includes approximately 117 sq. mi. of area in the physiographic province known as the Crawford upland. Nearly flat-lying sedimentary rocks of late Mississippian and early Pennsylvanian age underlie the hilltops and slopes, and unconsolidated silts, sands, and gravels, mostly of Pleistocene age, partly fill the major valleys.

Exposed rocks of late Mississippian age are assigned to the Blue River, West Baden, and Stephensport groups (new names), in ascending order. Of the Blue River group, which includes 3 formations that consist largely of limestone, only the upper 70 ft. is exposed. The West Baden group is approximately 115 ft. thick and consists of 5 formations which are made up principally of shales but include also some sandstones and limestones. The Stephensport group is approximately 140 ft. thick and consists of almost equal parts of limestones, sandstones, and shales belonging to 5 formations.

Between rocks of late Mississippian age and the rocks of early Pennsylvanian age that overlie them is an unconformity that represents a period of erosion of sufficient duration to have beveled the older rocks and then carved into them valleys as much as 100 ft. deep. Statistical analysis of available observations indicates that sandstone deposits in the lower part of the Mansfield formation are not concentrated at the unconformity and that limestone is not more abundant immediately under the unconformity than would be expected from the percentage of limestone in the rocks on which the unconformity was developed, but highly aluminous clays are concentrated at the unconformity, probably as a residual deposit.

Rocks of early Pennsylvanian age in the area are assigned to the Mansfield formation, have a maximum exposed thickness of approximately 250 ft. in the SW. corner of the area, and consist of sandstones, shales, and mudstones, and thin and discontinuous beds of coal and clay. The Mansfield formation is divisible into 2 parts, a lower part consisting largely of cross-bedded sandstones and an upper part made up principally of mudrocks and thin-bedded sandstones that have gray shale partings.

Coal, crushed limestone, whetstones and grindstones, Fe ore, dimension sandstone, and clay have been produced from the rocks of the area but are no longer of economic importance. The only mineral raw material now produced in quantity is gypsum, which is taken from rocks of middle Mississippian age in underground mines in the western part of the area.--Auth.

3-2506. Schmidt, Robert George, and others. GEOLOGY OF THE LLOYD QUADRANGLE, BEARPAW MOUNTAINS, BLAINE COUNTY, MONTANA: U. S. Geol. Survey, Bull. 1081-E, p. 159-188, 2 maps incl. col. geol. map (in pocket), scale 1:31,680, table, 1961, 35 refs.

The Lloyd quadrangle includes part of the north-eastern Bearpaw Mountains and part of the bordering plains and is underlain by sedimentary rocks of Middle Jurassic to Eocene age, by intrusive and extrusive igneous rocks of middle Eocene age, and by surficial deposits of late Pliocene(?), Pleistocene, and Recent ages. The sedimentary rocks are subdivided into 19 formations that have an aggregate thickness in the Bearpaw Mountains region of about 8,000 ft. The igneous rocks represent the shonkinite-syenite and monzonite families. Intrusive varieties occur as stocks, plugs, dikes, and sills. Extrusive varieties are part of a northern volcanic field that consists of interlayered mafic and felsic lava flows and pyroclastic rocks. The maximum stratigraphic thickness of the layered volcanic sequence is about 15,000 ft. Surficial deposits include pediment and terrace gravels, glacial deposits, and alluvium with an aggregate thickness of about 150 ft.

The principal structural feature of the area is the Bearpaw Mountains structural arch, an eastward-



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trending belt of uplifted and deformed sedimentary rocks that has been extensively intruded by igneous rocks. The arch is bounded by a northern and southern volcanic field. Part of the northern limb of the arch and the eastern part of the northern volcanic field lie in the Lloyd quadrangle. The layered units of the northern volcanic field dip southward toward the arch at angles of  $10^{\circ}$  to  $50^{\circ}$ .

Mineral resources include natural gas in the Bowes dome; minor amounts of bentonite, lignite, and low-rank coal; road metal; riprap; and gravel and sand. --R. G. Schmidt.

**3-2507.** Pray, Lloyd C. **GEOLOGY OF THE SACRAMENTO MOUNTAINS ESCARPMENT, OTERO COUNTY, NEW MEXICO:** New Mexico, Bur. Mines & Mineral Resources, Bull. 35, 144 p., 34 figs., 2 pls. (incl. 2 col. geol. maps, scale 1:31,680), 12 secs., 1961, 85 refs.

The Sacramento Mountains constitute a sharply asymmetrical cuesta at the eastern edge of the Basin and Range province in S.-central New Mexico, the escarpment rising abruptly for more than a mile above the Tularosa basin. This W.-facing escarpment has been carved in an uplifted fault block composed largely of sedimentary rocks having an aggregate thickness of about 8,000 ft. and ranging from Precambrian to Cretaceous in age but largely of Paleozoic age. Most of the pre-Pennsylvanian formations are thin and laterally persistent across much of southern New Mexico. The Pennsylvanian and Permian units are thicker and show greater lateral variability as a result of more tectonic instability and diastrophism than prevailed earlier.

Paleozoic units above the slightly metamorphosed late Precambrian sediments and diabase sills are the Ordovician(?) Bliss sandstone, the Ordovician El Paso, Montoya, and Valmont formations, the Silurian Fusselman formation, the Devonian Onate, Sly Gap, and Percha formations, the Mississippian Caballero, Lake Valley, Rancheria, and Helms formations, the Pennsylvanian Gobbler (and its Bug Scuffle limestone member), Beeman, and Holder formations, and the Permian Bursum (Laborcita), Abo (with the Pendejo tongue of the Hueco limestone), Yeso, and San Andres (including the basal Hondo sandstone member) formations. Bioherms mark the Lake Valley and Holder formations. The Pennsylvanian strata record increasing tectonism during the period, with progressive differentiation of a positive area in the E. and a more negative area, the Oregrande basin, to the W.

Mesozoic rocks occur as a small outlier along the crest of the range and are considered as part of the Dakota(?) sandstone. Quaternary deposits consist of terrace and pediment gravels, travertine, and slump material. Tertiary(?) igneous rocks, mostly andesite-latite, occur as sills and dikes.

The Sacramento Mountains are a tilted fault-block range bounded on the W. by a gravity fault zone as suggested by piedmont scarps, numerous small step faults, truncation of internal structure of the range, and the regional tectonic pattern. Estimated minimum displacement along the boundary fault is about 7,000 ft. for the central part of the range. Many anticlines, synclines, and high-angle faults were formed prior to uplift of the mountain block, mostly by major diastrophic movements during late Pennsylvanian and earliest Permian (pre-Abo) time. The intensity of this pre-Abo deformation appears to have increased from W. to E. toward an area of maximum pre-Abo uplift and erosion. Numerous small thrust faults and related zones of abrupt flex-

ure probably are related to the frontal fault system. Gentle folds and several normal fault systems high in the range probably formed between late Cretaceous and late Tertiary time. The major uplift of the mountain fault block is believed to have started in late Tertiary time; fault scarps in Recent alluvium indicate the uplift is continuing at the present time. --Auth. & F. E. Kottowski.

**3-2508.** Shelburne, Orville B., Jr. **GEOLOGY OF THE BOKTUKOLA SYNCLINE, SOUTHEASTERN OKLAHOMA:** Oklahoma Geol. Survey, Bull. 88, 84 p., 18 figs., col. geol. map (in pocket), scale 1 1/2 in. to 1 mi., 1960, 46 refs.

As mapped for this report the Boktukola syncline area includes 316 sq. mi. in the central Ouachita Mountains in McCurtain, Pushmataha, and Le Flore counties.

Outcropping rocks are Late Mississippian and Early Pennsylvanian; they are in ascending order, Stanley group, Jackfork group, Johns Valley formation, and Atoka formation. The rocks are a thick flysch facies aggregating 23,000 ft.; they were deposited in a rapidly subsiding trough, the Ouachita geosyncline. Flysch characteristics include rhythmic alternation of shale and sandstone, abundance of sole markings and convolute bedding, presence of bedded dark chert and intraformational slump structures, and paucity of fossils, coarse cross-bedding, and ripple marks.

Formations of the Stanley group, described from outcrops in the western Ouachitas, are present in the Boktukola syncline. The formations are, in ascending order, Tenmile Creek, Moyers, and Chickasaw Creek. The oldest rocks exposed in the area are in the lower part of the Tenmile Creek formation. The formation consists of green and gray shale with some graywacke; the name Battiest chert member is proposed for a persistent marker bed which occurs near the middle.

The Moyers formation consists of 1,150 ft. of green shale, friable sandstone, and resistant gray sandstone. A thin discontinuous siliceous shale, which is locally intruded by sandstone dikes, marks the base of the formation.

The Chickasaw Creek formation marks the top of the Stanley group; it consists of 140 ft. of dark siliceous shale, radiolarian chert, and quartzitic sandstone.

The formations of the Jackfork group are, in ascending order, Wildhorse Mountain, including the Prairie Hollow member, Prairie Mountain, Markham Mill, Wesley, and Game Refuge. Most of the siliceous shales which mark the boundaries of the formations in their type areas in the western Ouachitas are absent in the Boktukola syncline; therefore, the Prairie Mountain and Markham Mill formations can not be adequately separated. The Jackfork group is 55% subgraywacke and quartzose sandstone, and 45% gray shale. Spicular chert occurs in the Wesley formation. The group thickens eastward, toward the source area; it is 5,400 ft. thick in the Harris Creek syncline and 6,500 ft. thick in the eastern Boktukola syncline.

The Johns Valley shale is recognized in the area; however, exotic boulders or the Caney fauna have not been found. A Morrow sandstone mold fauna, Honess' "Morrow fauna," occurs in lenticular sandstones in the middle part of the Johns Valley.

An unknown thickness of the Atoka formation has been removed by erosion, but 6,800 ft. remain in the Boktukola syncline. The formation is about 75%

shale and 25% quartzose sandstone. The lower part of the Atoka is probably Morrowan; it contains a mold fauna, similar to that of the Johns Valley, and spicular siliceous shales.

The Boktukola fault is a steeply dipping thrust with a maximum displacement of 6 mi. and a trace of 30 mi. It is not a reasonable vehicle for low-angle overthrusting.

Primary sedimentary features typical of a flysch facies are common. Flute and groove casts are similarly aligned throughout the sequence. They indicate paleocurrents moving from E. to W., parallel to the geosyncline. Sediment transport was longitudinal, and the source area lay to the E. The lack of postdepositional torsion of the trends of sedimentary features indicates that the Ouachita orogeny was not so intense as some workers suppose.--Auth.

3-2509. King, Philip B., and Herman W. Ferguson. GEOLOGY OF NORTHEASTERNMOST TENNESSEE, With a Section on the Description of the Basement Rocks by Warren B. Hamilton: U.S. Geol. Survey, Prof. Paper 311, 136 p., 27 figs., 19 pls. (10 in pocket incl. 5 col. geol. maps, scales 1:12,000, 1:48,000, 1:125,000, and 1:500,000, col. sec., scale 1:48,000) 1960, 95 refs.

This report deals with the stratigraphy, structure, geomorphology, and mineral resources in an area of 660 sq. mi. in the northeastern corner of Tennessee. The area lies on the Unaka province of the Appalachian Mountains, between the Appalachian Valley and the Blue Ridge province.

Most of the area is formed of a sequence of sedimentary rocks 12,000 to 18,000 ft. thick, belonging to the Lower, Middle, and Upper Cambrian series and the Lower Ordovician series. The lower part of the Lower Cambrian, or Chilhowee group, consists of clastic rocks, including sandstones and quartzites that project in high mountain ridges. This group lies unconformably on Precambrian basement rocks, exposed mainly toward the SE. The remainder of the Cambrian, and the lower Ordovician, is a sequence of carbonate rocks, interrupted by only a few shaly formations. Middle Ordovician rocks, exposed in the Appalachian Valley along the NW. side of the area, are a body of clastic rocks more than 5,000 ft. thick.

The Precambrian, Cambrian, and Ordovician rocks have been repeated on a grand scale by many low-angle thrust faults. Along the major thrust, or Holston Mountain fault, rocks of the upper plate have been moved more than 18 mi. northwestward. Erosion of the deformed upper plate has produced an extensive window near Mountain City and a large thrust outlier near Shady Valley.

Hydrothermal mineral deposits of sphalerite, pyrite, and barite were emplaced in the rocks at about the time of the deformation, in later Paleozoic time. During the long period of erosion in Tertiary time residual mineral deposits of iron and manganese oxides and of bauxite accumulated in the surficial materials that overlie the bedrock. Many of the mineral deposits have been prospected or mined, and large tonnages of concentrates of iron and manganese oxides have been produced.--P. B. King.

3-2510. Bergendahl, M. H., and others. GEOLOGY AND MINERAL DEPOSITS OF THE CARLILE QUADRANGLE, CROOK COUNTY, WYOMING: U.S. Geol. Survey, Bull. 1082-J, p. 613-706, 7 figs., 6 pls. (5 in pocket, incl. 3 col. geol. maps, scales 1:1,200,

1:2,400, 1:24,000), 4 tables, 1961, 52 refs.

Situated along the northwestern flank of the Black Hills uplift, the Carlile quadrangle is underlain by Mesozoic sedimentary rocks that locally contain economic amounts of U, bentonite, and petroleum. The rocks of Jurassic age include marine shales and thin limestone and sandstone of the Redwater shale member of the Sundance formation and variegated claystone of the Morrison formation. Overlying the Morrison is a thick sequence of Cretaceous rocks, beginning with the predominantly sandstone and siltstone facies of the Inyan Kara group. This is followed by marine shales, limestones, and sandstones comprising the Skull Creek shale, the Newcastle sandstone, the Mowry shale, Belle Fourche shale, Greenhorn formation, and Carlile shale. Throughout most of the quadrangle the rocks dip gently westward at less than 2°, but locally they are warped into small anticlines, synclines, domes, or basins. Part of the Black Hills monocline crosses the SW. corner of the quadrangle, and in this area the rocks dip from 10-20° to the SW.

The rocks contain scattered deposits of U and bentonite, and local accumulations of petroleum. The U deposits are in the Lakora formation, the lower formation of the Inyan Kara group. The Carlile mine is a deposit of carnotite and tyuyamunite in a sandstone lens, whereas the nearby Thorn Ridge deposit contains a black sooty U mineral in a similar sandstone host rock. Bentonite has been mined from the Mowry shale; other minable beds of this mineral occur in the Newcastle sandstone. Although exploration for petroleum has been unsuccessful in the quadrangle, several small anticlines, hitherto undrilled, may be worthy of consideration, especially in view of recent successful development of similar structures to the W. and SE. of the quadrangle.--M. H. Bergendahl.

3-2511. Mapel, William J. GEOLOGY AND COAL RESOURCES OF THE BUFFALO-LAKE DeSMET AREA, JOHNSON AND SHERIDAN COUNTIES, WYOMING: U.S. Geol. Survey, Bull. 1078, 148 p., 6 figs., 23 pls. (18 under separate cover, incl. col. geol. map, scale 1:48,000), 4 tables, 1959, pub. 1961, 67 refs.

The Buffalo-Lake DeSmet area includes about 640 sq. mi. in N.-central Wyoming on the eastern flank of the Bighorn Mountains and the western margin of the Powder River basin.

Sedimentary rocks exposed in the area have an aggregate thickness of about 17,500 ft. They unconformably overlie igneous and metamorphic rocks of Precambrian age exposed along the western border of the area in the core of the Bighorn Mountains. Sedimentary rocks ranging in age from early Paleozoic to Paleocene crop out in narrow bands adjacent to the mountain front. Rocks of Eocene age cover most of the area E. of the foothills. Terrace and pediment deposits, alluvium, colluvium, and landslide material of Quaternary age occur locally.

Mesozoic and Paleozoic rocks adjacent to the mountains at some places stand vertically or are overturned. Intense folding in this belt is accompanied by thrusting to the E. along northward-trending high-angle reverse faults. Conglomeratic members of the Eocene Wasatch formation overlap the deformed older formations near the mountains and are themselves folded, although much less severely. Within 3 to 5 mi. E. of the mountains the Wasatch formation becomes nearly flat lying and



is relatively undisturbed by faulting.

Commercially important deposits of coal occur in the Wasatch formation. The coal varies in rank within narrow limits between lignite and subbituminous C. A coal bed that locally may be as much as 220 ft. thick, including thin partings of shale, underlies an area of about 2 1/2 sq. mi. near the N. end of Lake DeSmet. Other beds ranging in thickness from a few inches to 35 ft. crop out in the central and eastern parts of the area. The estimated total coal reserves amounts to about 6,400 million short tons. --Auth.

**3-2512.** Murray, Grover E., and others. **GEOLOGIC SUMMARY OF POTRERO PADILLA, COAHUILA, MEXICO:** Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 3, p. 392-396, 2 figs., March 1961, 7 refs.

The Potrero de Padilla is the southeastern part of the bilobate Berrendo-Padilla anticline which makes up Sierra de Padilla in central Coahuila. The

Potrero, a huge natural corral, occupies the breached axial area of the mountain-forming anticline. The bedrock is of Cretaceous age, listed in ascending order from the anticlinal core outward: Patula? arkose, 50 m. thick; Padilla limestone, 125 m.; La Mula? shale, 150 m.; Cuchillo-Taraises formation, 650 m.; Cupido limestone, the upper unit of the Coahuilan series, 310 m.; La Peña formation, 58 m., and Aurora limestone, 350 m., of the Comanchean series; and 500 m. of undifferentiated Cretaceous sediments containing Washitan, Woodbinean, and Austinian equivalents.

The Berrendo-Padilla anticline is a relatively symmetrical, doubly plunging, bilobate fold trending about N. 10°W. Dips on the flanks range from about 30° in the ridge-forming Aurora limestone to about 75° in the relatively nonresistant beds near the axis. Faults are common, especially bedding-plane faults. Drag folding was mapped in the northern part of the Potrero and with associated fractures localized the high-grade lead carbonate ores found in the Cuchillo-Taraises formation. --F. E. Kottowski.

## 2. GEOMORPHOLOGY

See also: Structural Geology 3-2538; Stratigraphy 3-2566, 3-2567.

**3-2513.** Sullivan, Walter. **NEW ICE ISLAND IN ARCTIC:** New York Times, v. 110, no. 37,746, p. 1, col. 3, p. 29, col. 2-3, map, May 29, 1961.

The U. S. Navy has discovered, named Arlis II, and established a research laboratory station on an island of ice 50 ft. thick, 2 mi. wide, and 3 1/4 mi. long in the Arctic Ocean 150 mi. N. and slightly E. of Point Barrow. A feature quite unique to this island is the presence of boulders, some as large as 6 ft. in diameter, in heaps up to 50 ft. high. This discovery supports the theory of rafting to explain the presence of large boulders in deep ocean sediments. --M. Russell.

**3-2514.** Péwé, Troy L. **UNIVERSITY OF ALASKA, GULKANA GLACIER EXPEDITION:** Arctic, v. 14, no. 1, p. 74-75, March 1961.

Report on glaciological investigations on Gulkana Glacier in the central Alaska Range conducted by members of the Dept. of Geology, University of Alaska, during summer 1960. Briefly describes field procedure; ablations studies, movement, and structure studies; geophysical measurements; and glacial geology. --L. M. Dane.

**3-2515.** Løken, Olav. **A STUDY OF GLACIAL GEOMORPHOLOGY IN THE NORTHERN TORNGAT MOUNTAINS, LABRADOR:** Arctic, v. 14, no. 1, p. 75-76, March 1961, ref.

Brief report on results of a study conducted by the author in summers 1959 and 1960. Study of the post-glacial emergence shows a discontinuous displacement of the strand line; 3 well-developed strand lines were found. An equal-distance diagram has been plotted and shows that a major transgression took place in northern Labrador prior to the formation of the lowest strand line (15.5 m. above sea level). Fossil marine molluscs indicative of a boreal-arctic fauna were found up to 32 m. above sea level in the base camp area. Several terminal moraines were located; correlation between them has been possible because of the study of strand lines. --L. M. Dane.

**3-2516.** Ives, J. D. **GLACIATION AND DEGLACIATION OF THE HELLUVA LAKE AREA, CENTRAL LABRADOR-UNGAVA:** Geog. Bull., no. 15, p. 46-64, 13 figs. incl. map, scale 1:50,000, 1960, pub. 1961, 16 refs.

The process of disintegration of the last ice-sheet N. of the final 'ice-divide' in central Labrador-Ungava is presented, based on field investigation and airphoto interpretation. It is estimated that prior to deglaciation an over-all regional slope of 1:140 existed toward the N. with fairly rugged subglacial relief. Progressive melting first exposed the highest summits in the northern part of the area. Further thinning then exposed the flanks of the higher hills and ridges, and glacial channels were formed, principally in sub-lateral and subglacial positions. Outwash deposits and dead-ice topography resulted from additional thinning and from the recession of the broken and irregular ice-front. In the final phase the N. was ice-free, although a number of detached pieces remained in the S. as higher land emerged in the neighborhood of the ice-divide. The relative scarcity of ablation moraines throughout the area implies that the ice was relatively clean. The final direction of ice movement was toward the N., and it is suggested that the position of the ice divide at the time of formation of the drainage channels coincided approximately with a final center of ice dispersal at an earlier date. --Auth.

**3-2517.** Ives, J. D. **FORMER ICE-DAMMED LAKES AND THE DEGLACIATION OF THE MIDDLE REACHES OF THE GEORGE RIVER, LABRADOR-UNGAVA:** Geog. Bull. no. 14, p. 44-88, 15 figs., 1960, 19 refs.; text in English & French.

A combination of field work and air photo interpretation forms the basis of this paper which is a study of the glacial features of the middle George River and the plateau country on either side. Particular emphasis is placed upon a precise survey of the extent and tilt of a spectacular series of glacial lake shorelines. The extrapolation of the data obtained by parallax methods from this survey allowed for the coverage of a much larger area than could be covered on the ground. The glaciofluvial and glaciolacustrine features are interpreted in the light of

existing topographical knowledge of the northeastern sector of the peninsula, and this allows the broad outlines of the deglaciation to be drawn. It is concluded that glacial lakes, hundreds of miles in extent, were dammed between the Atlantic watershed and ice masses to the W. and N. Ungava Bay was occupied by a large mass of ice in late-glacial time. --Auth.

3-2518. Mackay, J. Ross. CREVASSE FILLINGS AND ABLATION SLIDE MORAINES, STOPOVER LAKE AREA, N. W. T.: *Geog. Bull.* 14, p. 89-99, 4 figs., 1960, 9 refs.; abs. in English & French.

A complex pattern of crevasse fillings, eskers and ablation slide moraines resembling dead-ice landscape occurs in an area of 40 sq. mi. in the vicinity of Stopover Lake, 80 mi. N. of Smith Arm, Great Bear Lake, Northwest Territories. Open fissures and crevasses of stagnant ice appear to have received deposits of sediment which were transported into the area by a large river whose abandoned channel lies to the E. of Stopover Lake. At the time of deposition the controlling water level was from 1,150 to 1,250 ft. above sea level. Following a rapid lowering of the water level to below 1,150 ft., ablation slide moraines, which may be annual features, were formed by the chuting, sliding, and slumping of ablation material down the sides of wasting ice-blocks left by the retreating ice front. --Auth.

3-2519. Sim, Victor Wallace. A PRELIMINARY ACCOUNT OF LATE "WISCONSIN" GLACIATION IN MELVILLE PENINSULA, N. W. T.: *Can. Geographer*, no. 17, p. 21-34, 8 illus., 5 maps, Nov. 1960, 8 refs.

The glacial movements discussed here took place when deglaciation was well under way in northeastern North America. At that time, small, local centers of active ice dispersal developed. One of these lay in the area of eastern Foxe Basin. A smaller independent ice cap may also have existed on Southampton Island, or in northern Hudson Bay, at roughly the same time.

Two major directions of ice movement across the peninsula are clearly indicated. N. of Rae Isthmus movement appears to have been across the peninsula in a WNW. direction. A study of drumlinoids, roches moutonnées, and crag-and-tail features suggests this conclusion. Swaths of limestone-charged ground moraine tailing out towards the W. from the eastern sedimentary lowland, and a decrease in the number of sedimentary erratics with increasing distance W. across the upland, also support the theory of E.-to-W. glacial movement. An eastward projection of the line of general trend of these glacial indicators suggests that the source area for the ice lay in southeastern Foxe Basin.

A second major direction of glacial advance is indicated on Rae Isthmus. Here drumlinoid topography with a pronounced SE.-NW. alignment apparently resulted from movement to the NW. from a dispersal center on Southampton Island or in northern Hudson Bay.

Whether or not the ice moving WNW. from Foxe Basin and NW. from Southampton Island were contemporaneous in their passage across the peninsula is difficult to say. The apparent absence of any interlobate material in the area N. of Haviland Bay suggests that they were not precisely so; the more recent movement may have removed in its passage any debris left by the earlier one in the area over

which it passed.

Over most of the peninsula, then, the most recent ice movement appears to have been westward and northwestward as a broad lobe extending at its maximum from the latitude of Fury and Hecla Strait southward to at least the latitude of Repulse Bay. It may have been this ice which prevented S.-moving ice in northern Baffin Island from crossing Fury and Hecla Strait or, if the N. Baffin ice had previously crossed, which removed any evidence of southerly movement on Melville Peninsula.

How far W. the ice advanced is unknown. No glacial flow lines or movement indicators appear on Wales Island. The few which appear on Simpson Peninsula suggest an ice movement there from S. to N. But it seems reasonable to assume that ice from a Foxe Basin-northern Hudson Bay source covered Committee Bay, portions of Simpson Peninsula, and the southern part of the Gulf of Boothia.

To the N., the Melville Peninsula ice mass probably merged in the vicinity of Fury and Hecla Strait with W.- and SW.-flowing ice from northern Baffin Island. In the S. it may have met ice moving N. from northeastern Keewatin. Finally, it seems possible that an interlobate area existed in southern Gulf of Boothia between the Melville Peninsula-Foxe Basin ice and ice moving in a northeasterly direction over Boothia Peninsula.

When final ablation began in late "Wisconsin" time the ice appears to have melted by downwasting. As the ice thinned, the high backbone of the peninsula was the first area to emerge. This event separated ice over Committee Bay from the larger mass over the peninsula and Foxe Basin. A kame moraine formed at the eastern margin of the remnant mass in Committee Bay.

With continued eastward retreat of the western margin of the peninsular ice, the W. coast valleys were exposed and filled with outwash. Contemporaneously the W. coast eskers were formed. These features were all built, however, in a comparatively short period of time. Ablation soon placed the western edge of the ice E. of the stream divide, and subglacial and proglacial drainage to the W. was impeded.

As the Wisconsin glacial stage drew to a close, the melting of vast amounts of ice to the S. raised the sea level, flooding low-lying areas. Sea water probably lapped about the edges of ice in Foxe Basin, hastened its melting, and separated it from the residual ice over the peninsula. The eskers and outwash material N. of Repulse Bay and Haviland Bay, N. of Barrow River, and on the eastern Paleozoic lowland all formed in meltwater streams flowing radially to the ice margin at this stage.

Finally, the ice on the peninsula divided into 2 portions: a small remnant cap in the N., and a larger mass centered SW. of Parry Bay. The northern mass was the first to disappear. Ice remained longest in the area covered by ablation moraine and glacial drainage channels W. of Parry Bay. Here lay a heavily drift-charged ice mass from which drained torrential, E.-flowing glacial streams capable of cutting the channels. By that time the ice over Foxe Basin itself had disappeared, and the present Barnes icecap on Baffin Island had shrunk almost to its present size. --Auth. summ.

3-2520. Kaye, Clifford A. SURFICIAL GEOLOGY OF THE KINGSTON QUADRANGLE, RHODE ISLAND: *U.S. Geol. Survey, Bull.* 1071-I, p. 341-396, 17 figs. 3 col. maps (in pocket), scale 1:24,000, 1960, 35 refs.

The eastern third of the Charlestown moraine -



the mainland segment of the Harbor Hill-Buzzards Bay morainic alignment - lies in the quadrangle. It probably formed as an ablation moraine developed at the edge of the ice during a retreatal stillstand. The moraine consists largely of ridges and mounds that are interpreted to be ice-fracture fillings and ice-block casts, respectively. The recognition of Pleistocene ablation moraines is discussed in detail because this type of deposit is important in the Kingston quadrangle. Deposits of ablational origin are characterized by one or more of the following: stratified till, wide variations in sorting, interstratification of till and sorted drift, large-scale bedding distortions, ice-fracture fillings and the tendency for bedding of superficial strata to parallel surface. Ice receded from the area by downwastage. Where ice was insulated by a thick ablation moraine, its melting was retarded. Several of the ablation moraines had cores of stagnant ice long after clean ice to the N. had melted. At first these ice-cored moraines were somewhat pervious to drainage from the N. but as the ice core shrank they transformed into large earth dams that impounded a lake, glacial Lake Worden.

Deposits of only one glaciation are recognized although there is evidence of an older buried drift. The age of the Charlestown moraine is possibly late Wisconsin (Cary?). Well-formed ice-wedge structures, buried frost-riven boulders, and other features indicating deep ground ice or permafrost occur and indicate an interval of severe climate after deposition of the drift. No evidence of sea levels higher than the present were recognized.--Auth.

**3-2521. Henoch, W.E.S. FLUVIO-MORPHOLOGICAL FEATURES OF THE PEEL AND LOWER MACKENZIE RIVERS:** Geog. Bull., no. 15, p. 31-45, 9 figs., table, 1960, pub. 1961, 7 refs.

The fluviomorphological aspects of Peel River near its confluence with Mackenzie River [Yukon Territory-Mackenzie District] are described in relation to the building of alluvial plains. Features of the discharge and sedimentation of Peel River are presented. Flooding at the time of spring break-up, the presence of permafrost, and the sparseness of vegetation are factors in the building of these plains. Alluviation proceeds mainly by the deposition of sediments when floodwaters overflow the river banks. An anomalous feature of the rivers in the area studied is the reversal of flow during the spring flood which results in the building of levees along distributary channels and birdfoot deltas in the lakes into which these channels drain.--Auth.

**3-2522. Merrill, Glen K. ADDITIONAL NOTES ON VERTICAL SHAFTS IN LIMESTONE CAVES:** Natl. Speleol. Soc., Bull., v. 22, pt. 2, p. 101-108, 4 figs., July 1960, 7 refs.

The life cycles of domepits illustrate characteristic relationships to the stratigraphy and physiography of the area and to each other. They originate from the action of meteoric waters, and their general form is a result of the highly uniform characteristics of the limestone bedrock and a zone of concentrated water seepage either in a sinkhole or along ridge margins. Usually they are formed where ravines intersect the ridge. The domepits frequently occur in series, developing along with headward valley erosion. The shafts are normally smaller in both depth and diameter in their relation headward along valleys. Both seeping (solution) and dripping (solu-

tion and abrasion) water help to excavate the walls and floor of the domepit.

Local resistant strata can restrict or entirely stop domepit formation, frequently resulting in the forming of shafts beneath the original ones.--Auth.

**3-2523. Davies, William E. METEOROLOGICAL OBSERVATIONS IN MARTENS CAVE, WEST VIRGINIA:** Natl. Speleol. Soc., Bull., v. 22, pt. 2, p. 92-100, 9 figs., table, July 1960, 3 refs.

Measurements of flow and temperature of air and water in Martens Cave near Lobelia, West Virginia, were made from 1948 to 1960. The main passage of Martens Cave, 800 ft. long, extends through a low hill. Air temperature in this part of the cave reflects seasonal variation in surface temperature with a slight time lag. The highest temperature in the main passage is 53°F. which is the same as the mean annual surface temperature; the coldest is 27°F. In other parts of the cave temperatures are 49° to 53°F. throughout the year. The stream flowing through the main passage loses heat at the rate of 2°F. per hundred feet in the cave in summer to a stable temperature of 53°F. In winter it gains very little heat except from a small side stream which joins it 500 ft. inside the cave causing a temperature rise of 2°F. In the rocks enclosing the cave there is a net yearly heat gain of about 7,000,000 BTU.--Auth.

**3-2524. Holly, Frank. SPELEOLOGY IN HUNGARY:** Natl. Speleol. Soc., Bull., v. 22, pt. 2, p. 85-91, 3 figs., July 1960.

Although a small country, Hungary is rich in karst areas and caves. Many of the latter were known from antiquity; but since World War II numerous new ones have been discovered. Notable among them is the Béke barlang, smaller than its famous neighbor, Baradla, but probably more beautiful. Great impetus to speleology in Hungary has been given by many speulunking groups formed of youngsters, students, and tourists. These groups have recently been coordinated by the formation of the Hungarian Speleological Society. Since there is a great demand for exact cave discovering methods, the development and use of physical and chemical methods has started.--Auth.

**3-2525. Halliday, William R. PSEUDOKARST IN THE UNITED STATES:** Natl. Speleol. Soc., Bull., v. 22, pt. 2, p. 109-113, 6 illus., July 1960, 11 refs.

Features analogous to those characteristic of karstic areas are distributed widely in the western United States, but have received little study. The most obvious of these are found in basalt flows, but they also occur in littoral zones, glaciers, and certain poorly consolidated sediments. These features must be considered in defining terms applied to geomorphic forms which occur in either karst or pseudokarst.--Auth.

**3-2526. Schumm, Stanley A., and Richard F. Hadley. PROGRESS IN THE APPLICATION OF LANDFORM ANALYSIS IN STUDIES OF SEMIARID EROSION:** U.S. Geol. Survey, Circ. 437, 14 p., 9 figs., 1961, 14 refs.

The analysis of topographic and hydrologic data gathered during studies of erosion in semiarid areas of western United States show the following relation: a) mean annual sediment yield from small drainage basins is related to a ratio of basin relief to length; b) mean annual runoff from small drainage basins

related to drainage density; c) mean annual sediment yield per unit area decreases with increase in drainage area; d) the form of some convex hill slopes is related to surficial creep; e) asymmetry of drainage basins, including differences in hill-slope erosion and drainage density, is related to microclimatic variations on slopes of diverse exposure; f) the cutting of discontinuous gullies is closely related to steepening by deposition of the semiarid valley floor; g) aggradation in ephemeral streams seems to be most prevalent in reaches where the ratio of contributing drainage area to channel length is relatively small; and h) stream-channel shape, expressed as a width-depth ratio, is related to the percentage of silt-clay in bed and bank alluvium.

The above relations cannot be detected without measurement of terrain characteristics. They further indicate the importance of quantitative terrain analysis in studies of erosion.--Auth.

**3-2527. American Geological Institute. FIELD CHECK LIST FOR SOILS.** Adapted by Sidney White: *Its: AGI Data Sheet 25, 2 p., in GeoTimes, v. 5, no. 8, p. 31-32, May-June 1961; also pub. separately.*

This check list for examination and description of soils was adapted from U. S. Dept. of Agriculture, Handbook No. 18, Soil Survey Manual. Points on the list include soil type, classification, native vegetation, climate, parent material, physiography, relief, slope, drainage, ground water, permeability, moisture, salt or alkali, stoniness, root distribution, horizon, depth, thickness, boundary, color, texture, structure, consistence, reaction, special features.--A. C. Sangre.

**3-2528. Lessig, Heber D. SOILS OF THE HIGH TERRACE REMNANTS IN THE UPPER OHIO VALLEY:** *Ohio Jour. Sci., v. 61, no. 1, p. 25-37, 3 figs., Jan. 1961.*

Soils developed on the highest, 960-1,020 ft., glacial outwash terrace in the upper Ohio Valley were studied to determine their nature and origin. The well-drained soils, developed in outwash, have properties of red-yellow podsolc soils, but the moderately well-drained and imperfectly drained soils are more like gray-brown podsolc soils. The soil parent materials belong to at least 2 geological events. The 960-1,020-ft. outwash belongs to the first glaciation of the Allegheny Plateau, but in some places at 960 ft. it is buried by lacustrine material which belongs to a later event. Colluvium was deposited along the valley wall contemporaneously with the lacustrine material. Another older layer of lacustrine material was found beneath the glacial outwash.--Auth.

**3-2529. Bloom, Arthur L. LATE PLEISTOCENE CHANGES OF SEA LEVEL IN SOUTHWESTERN MAINE:** 143 p., 7 figs., 5 maps, Augusta, Maine Geological Survey, Oct. 1960, 76 refs.

The evidence of late Pleistocene marine submergence of the coastal plain of southwestern Maine consists primarily of a sheet of gray, silty clay, containing a cold-water marine fossil fauna. The name "Presumpscot formation" is proposed for this sediment, from exposures in the Presumpscot River valley near Portland, Maine. In the eastern one-third of the area, the Presumpscot formation unconformably overlies glacial drift, and is known from well logs to overlie drift at depths of at least 60 ft.

below present sea level; an interval of subaerial exposure of the deglaciated landscape prior to submergence is indicated. This area of postglacial marine submergence coincides with an area of inferred southward flow of glacier ice.

Glacial lineations show that the final movement of glacier ice over the western two-thirds of the area was toward the SE., from the direction of the White Mountains. This glacial advance entered the sea and deformed previously-deposited beds of the Presumpscot formation when sea level was at least 40 ft. above its present position relative to the land. It is named the Kennebunk glacial advance from glacially-deformed marine beds exposed near Kennebunk, Maine.

Ice of the Kennebunk advance was impeded in its movement by a rugged upland region NW. of the coastal plain. Local bedrock relief of up to 1,000 ft. finally separated the thinning ice into detached valley-filling segments, which melted simultaneously over an area at least 25 mi. wide from SE. to NW. During this time of final deglaciation, the marine transgression reached its maximum extent. A line of deltas and delta fans built by meltwater streams marks the inland limit of marine submergence. The strandline of maximum submergence now increases in altitude toward the N. at about 2 ft./mi., providing one linear component of postglacial differential upwarping.

Marine submergence may have been in progress 11,800 years B. P., based on one  $C^{14}$  age determination on marine shells from Waterville, Maine. Pollen stratigraphy implies that reemergence was in progress 7,000-8,000 years B.P. Emergence was accompanied by differential upwarping toward the NW., presumably the result of postglacial isostatic recovery of the earth's crust.

At some time between 7,000-8,000 years B.P. and 4,200 years B.P. the coast of southwestern Maine was emerged at least 2 ft. and perhaps 8-9 ft. greater than present. Progressive submergence has continued from then to the present time.

If eustatic sea level has been near its present position for the past 5,000 years, as is suggested by accumulating evidence, then either the isostatic movement of the coast of Maine has reversed its direction, or other tectonic movements are causing coastal subsidence.--Auth.

**3-2530. SEAMOUNT IN THE GULF OF ALASKA:** *Military Engineer, v. 52, no. 348, p. 314, July-Aug. 1960.*

A large seamount at  $56^{\circ}\text{N.}$ ,  $143.2^{\circ}\text{W.}$ , was discovered by the U. S. Coast and Geodetic Survey ship *Pathfinder* in the fall of 1959. The truncated cone has a base 12 mi. in diameter and a crest of 1.25 mi., and rises 8,700 ft. to a depth below the surface of 3,984 ft. It makes the twentieth seamount known to extend in a chain from the floor of the Aleutian trench, 110 mi. E. of Kodiak Island, SE. toward Vancouver Island, and approximately 160 discovered by Survey ships in the Gulf of Alaska seamount province.--A. C. Mason.

**3-2531. Gordienko, P. A. THE ARCTIC OCEAN:** *Sci. American, v. 204, no. 5, p. 88-98, 100-102, illus., maps, sec., May 1961.*

This account of Soviet investigations of the arctic region shows them to be the result of efforts by early explorers to find a NE. passage between the Atlantic and the Pacific. Much of the article is devoted to history of such efforts and modern triumphs in this



field of endeavor. Modern misconceptions about arctic weather are corrected, and it is shown that a good deal of weather is generated, or modified, in the higher latitudes. From the drift of ice islands a good deal is deduced of Arctic Ocean currents, and samples taken through the ice show the biology and water masses of this ocean, described in some detail. Details of the Lomonosov ridge, running from Asia to North America across the pole, are included. Geomagnetic studies show the presence, not of a North Pole, but of a northern line of magnetic convergence about 30° long, roughly parallel to the Lomonosov ridge.--R. F. McAllister.

**3-2532.** Bates, Robert L. DRAINAGE DEVELOPMENT, SOUTHERN SACRAMENTO MOUNTAINS, NEW MEXICO: Ohio Jour. Sci., v. 61, no. 2, p. 113-124, 14 figs., March 1961.

The Sacramento Mountains of S.-central New Mexico are an asymmetrical fault block of Paleozoic sedimentary rocks, with a long gentle eastern slope draining to the Pecos River and a steep western escarpment fronting on the Tularosa basin. A zone of late Tertiary normal faulting bounds the range on the W. In the southern part of the range, a second normal-fault zone appears E. of the main one, and there the mountains rise in 2 escarpments. The asymmetrical trough formed by the back slope of the lower fault block and the steep escarpment of the higher one opens to the SE. and is drained by the Sacramento River and its tributaries (ephemeral streams, as are all those of the range). These conditions have set the stage for the spectacular development of stream piracy. Steep streams flowing into Tularosa basin are capturing drainage from the western limb of the Sacramento River basin and now threaten the main channel itself. The eastern tributaries of the Sacramento River, in turn, are capturing and reversing the headwaters of eastward-flowing Pecos River drainage. Examination of air photos, U. S. Forest Service contour maps, and the area itself reveals a multitude of barbed tributaries, elbows of capture, beheaded streams, and abrupt changes in gradient. These are described as illus-

trating the close control exercised by geologic structure in the early evolution of a drainage pattern.--Auth.

**3-2533.** Doerr, Arthur H. COAL MINING AND LANDSCAPE MODIFICATION IN OKLAHOMA: Oklahoma Geol. Survey, Circ. 54, 48 p., 16 figs., 1961, 8 refs.

Coal mining has been carried on in Oklahoma since the middle 1800's but did not become significant until 1872, reaching peak production of 4,849,388 tons in 1920, and declining to an average of 2,000,000 tons per year in recent times.

This activity has led to the development of hundreds of underground and strip mines over an area of 14,550 sq. mi. in the northeastern and E.-central parts of the state.

Underground mining creates topographic changes through the development of waste heaps and local subsidence. Generally the waste heaps are barren of vegetation because of the toxic character of the waste.

Strip mining has led to the stripping of an estimated 12 to 18 thousand acres of land and, at the present rate, an estimated 400 acres is stripped each year. Topographic modification by strip mining depends on the characteristics of the deposits and the method of mining. Generally the resultant forms are series of parallel ridges of spoil with moderate relief; in many places lakes are formed in the last excavation made.

Revegetation of stripped areas generally proceeds at a slow rate because of toxic constituents of the spoil and because of its low organic content. Replanting with suitable plants may accelerate the revegetation process, but replanting is not practiced widely in Oklahoma.

The effects of coal mining on the cultural landscape in most cases are of the boom-and-bust type where early development leads to rapid growth and prosperity of towns, followed by decline and decay as the coal resource is exhausted or loses its value for other reasons. Only those towns which can shift to another economic base can avoid the eventual decline.--Auth.

## 3. STRUCTURAL GEOLOGY

See also: Geophysics 3-2633; Mineral Deposits 3-2763.

**3-2534.** PRELIMINARY MOHOLE PROJECT DRILLING SUCCESSFUL: GeoTimes, v. 5, no. 8, p. 10-13, 5 illus., May-June 1961.

"New vistas in geologic knowledge and petroleum exploration came sharply into focus as the CUSS 1 completed the first phase of the Mohole Project experimental drilling near Guadalupe Island off the coast of Mexico. The specially designed diamond drill bit on a 4 1/2-in. drilling string was lowered over 2 mi. through open water from the 3,000-ton converted sea-going Navy barge before it made contact with the sea floor at 11,700 ft. and began to penetrate the earth's crust."

Two preliminary tests in 3,000 ft. of water off La Jolla, California, penetrated to a depth of 1,043 ft. below the bottom. Several deep-water rotary cores recovered Pleistocene(?) sands and silts of the turbidity current type, a zone of dolomite, and Pliocene(?) sands and silts. Subsequent tests were drilled off Guadalupe Island in 11,700 ft. of water. Several hundred feet of bottom materials were

penetrated, including Miocene clays and, at 560 ft. below the bottom, basalt. Geophysical measurements were made in the fourth Guadalupe testhole.

A tremendous amount of engineering, planning, and development remain before the attempt is made to drill to the Mohorovičić discontinuity. However, a major breakthrough in the methods of geologic exploration of the sea bottom has already been accomplished.--G. L. Foster.

**3-2535.** Salisbury, J. ORIGIN OF LUNAR DOMES: Lunar & Planetary Explor. Colloquium, Proc., v. 2, no. 2, p. 22-26, 3 figs., 1960, 10 refs.

Lunar domes have been explained variously as shield volcanoes, lava bubbles, or laccoliths. A fourth explanation is proposed, namely that the domes are the result of increase in volume of rock by serpentinization of peridotitic material by water vapor rising from the interior, as suggested by Hess to explain certain terrestrial domes and uplifts. It must be assumed that peridotitic material is present on the moon in temperature regions below 500° C. and

that there is subsequent introduction of water vapor released as the result of deep volcanic activity.--M. Russell.

3-2536. Krinov, E.L. THE KAALIJARV METEORITE CRATERS ON SAAREMA ISLAND, ESTONIAN SSR: *Am. Jour. Sci.*, v. 259, no. 6, p. 430-440, 9 figs., June 1961, 12 refs.

A group of 1 large and 6 small meteoritic craters in Estonia has been investigated in some detail, both morphologically and as to content of meteoritic fragments. Arguments are presented for considering the large crater an explosion crater arising from the collision of a large meteorite at remaining cosmic velocity. The explosion destroyed the meteorite and blasted the crater in the ground. The small craters, on the other hand, although arising from members of the same meteorite shower, are impact craters. The smaller fragments responsible for impact craters had been slowed down by atmospheric drag to the extent that they had no remaining cosmic velocity on impact, and no explosion occurred. Unlike the large crater, the small craters do contain fragments of meteorites.

The Estonian craters are compared with similar groups elsewhere, notably Sikhote-Alin, U. S. S. R.; Henbury, Australia; and Brenham, Kansas.--D. Hoffleit.

3-2537. Shoemaker, Eugene M. BALLISTICS OF THE COPERNICAN RAY SYSTEM: *Lunar & Planetary Explor. Colloquium, Proc.*, v. 2, no. 2, p. 7-21, 10 figs., 1960, 12 refs.

The distribution pattern of ejecta around lunar craters permits of unambiguous discrimination of impact craters from volcanic centers. From such a pattern it is clear that Copernicus crater is the result of impacting on the moon of a body of asteroid dimensions. A mathematical analysis of the ray pattern around Copernicus, drawing on data from cratering experiments on earth, ballistic theory, and statistical analysis of lunar photographs, leads to the conclusion that the asteroid which caused the crater of Copernicus expended in kinetic energy  $1.8 \times 10^9$  kilotons TNT equivalent or  $7.5 \times 10^{28}$  ergs.--M. Russell.

3-2538. Gaskell, T. F. UNDER THE DEEP OCEANS: TWENTIETH CENTURY VOYAGES OF DISCOVERY: 240 p., 8 figs., New York, W. W. Norton, 1960.

The 1872 Challenger expedition was one of the first of the world-wide cruises and set the pace for many more detailed studies of the deep oceans. In 1949 the Royal Navy mounted a similar expedition in a ship which also bore the name Challenger. This latter expedition serves as the framework for the book. The Challenger did not discover everything known about submarine geology, and accordingly the story of the Challenger voyage becomes almost submerged by the results obtained by other oceanographic research ships. However the kind of experiments made at sea and the difficulties inherent in studying the ocean floor are common to all oceanographic work, so that one personal experience can provide the example for many.

The most powerful tool of the submarine geologist today is the seismic method, and this was used by the Challenger to find out what rock layers existed beneath the sea floor. Apart from discovering whether the oceans are permanent or merely old land

that has been flooded, the seismic results show the amount of soft ocean sediments and the thickness of the earth's crust. Separate chapters are devoted to the various layers of rock that are found to constitute the floor of the oceans. Coral atolls and submerged flat-topped seamounts all fit into the simple picture proposed by Darwin in the last century, and the way in which this picture has been confirmed by new methods of measurement is shown in Chap. 6, Coral Atolls. The echo sounder has revealed a wealth of variety in the sea bed and has replaced the old concept of a uniform flat plain by a topography exhibiting mountain ranges, peaks, and valleys with even greater relief than can be seen on land. Temperature and current observations, bottom samples, and collections of plankton all help to show how the enormous volume of water is moving around the ocean basins.

The last part of the book is devoted to conclusions drawn from the increasing volume of information being assembled. The Mediterranean is seen to be a cross between the permanent oceans and the continents in its rock structure. This is because there has been a movement apart of Africa and Europe at some time in geologic history. Evidence for such movement is supplied in large part by oil companies' borings, which are revolutionizing geological thought in much the same way that naval research is changing the ideas of oceanographers. Geophysical techniques and aerial photographic surveys show the earth's surface in a broad and deep expanse, and oil geologists are leading the field in the modern ideas of geological history. Oil geologists have recently been joined by the physicists in questioning the doubts cast on the old hypothesis of continental drift. The question whether America, Europe, and Africa were all at one great land mass is not yet settled, but an attempt is made here to present the evidence without concluding one way or the other.

The final clue to many of the questions of how the earth reached its present form will be discovered during the next few years by drilling down to find out what lies beneath the crustal skin. The combination of oil techniques with the enthusiasm of oceanographers and the financial support of the navies of the world will provide the answers to the problems.--M. Russell, from auth. introd.

The book includes 12 chapters as follows: geographical exploration - modern style; the earth and the oceans; seismic prospecting; the Moho; deep sounding; coral atolls; layer 2; sea-bed sediments; natural history; the Mediterranean; wandering continents; deep drilling.

3-2539. THE EAST PACIFIC RISE: *Military Engineer*, v. 53, no. 351, p. 55, fig., Jan.-Feb. 1961.

The recently recognized E. Pacific rise extends 8,000 mi. in a curve from New Zealand to Mexico, and possibly northward. The crest is 2 mi. above the floor of the deep Pacific, and 1 1/2 mi. below the ocean surface, except for volcanic accumulations like Easter Island. Its western slope is gentle, about 10 ft. a mile. It is the site of many shallow earthquakes. Beneath its crest the crust of the earth thins to 2 mi. Heat flows through the crest at 8 times the rate in the deep ocean floor or on land. The rise has mountainous belts consisting of E.-W. fracture zones, containing most of the volcanoes in the eastern Pacific. Aligning magnetic anomalies indicate horizontal blocks may have shifted hundreds of miles.--A. C. Mason.

3-2540. Schmalz, Robert F. A CASE FOR CONVECTION: *Mineral Industries*, v. 30, no. 6, p. 1-8,



10 figs. incl. charts, diags., 2 tables, March 1961, 1 refs.

Anomalous heat flow values observed at sea show a distinct correlation with submarine topography and zones of tectonic activity. The anomalies appear inexplicable in terms of classical theories of crustal heat sources, and appear to be permanent features of the sea floor having their origin in the mantle below. Convection cells confined to the upper 850 km. of the mantle, similar in some respects to the "roller cells" of Hess, seem physically reasonable, and provide a unified explanation of the observed heat flow and apparently related topographic and tectonic features in certain areas. The proposed convection cells have been shown to fit remarkably well most phases of the observational data in the SE. Pacific.

Five, and possibly 6, additional areas bearing greater or less similarity to the SE. Pacific basin are cited as possible locations for convection cells, and the nature of available data in each is briefly discussed.

Fields of future study should emphasize the western North Atlantic where the most abundant data are already available, and should include careful heat flow measurements across the continental shelf and slope, the Bermuda basin and rise, and Mid-Atlantic ridge and Puerto Rican trough. These studies should be coupled with seismic studies of the basement configuration as well as with detailed topographic mapping. Studies in this area, rather than in the SE. Pacific, appear to offer greater promise since the SE. Pacific would appear to be a region where an unlikely coalition of factors may have conspired to frustrate analysis.

In addition, geomagnetic studies above the proposed rising currents might show persistent weak magnetic anomalies such as would be generated as the convecting material moved through the earth's magnetic field.

Finally, 2 highly speculative observations are offered.

The distribution of convection cells proposed shows a semisystematic distribution not unlike that described by Vening-Meinesz. In the present pattern rising currents are located in alternate hemispheres with descending currents surrounding them. The pattern is slightly distorted to allow the currents to rise beneath ocean basins, and the question might arise whether or not this distortion could contribute

differential stresses in the crust that could be invoked to explain continental drift.

Billings observed that tectonic zones often show periods of uplift long after erosion has reduced a primary orogenic feature to a surface of low relief. The periods of time involved indicate that isostatic equilibrium should have been achieved long before the initiation of this late uplift; and, to explain the phenomenon, Billings suggested that low density silicate material may have been added to the crust (at depth) beneath orogenic zones late in their history, thus reactivating isostatic uplift. The convection cells here proposed would provide a mechanism for introducing such low density material as silicate slag which accumulated at the point of descending or converging currents. In the Appalachians or the Andes, the mechanism would appear directly applicable. The mechanism might even be invoked to explain the origin of the continents themselves at an early period in the earth's history when convection was more rapid. --Auth. summ. & concl.

3-2541. Pronin, A.A. THE MAJOR STRUCTURES OF THE URALS AND THEIR ORIGIN: Akad. Nauk SSSR, Izvestiya, Geol Ser., in translation, 1959, no. 8, p. 57-63, map, pub. 1961, ref.

In order to understand the present structure of the Urals and the main characteristics of the development of the processes of sedimentation, volcanism, and tectonism, it is necessary to separate within the complex of rocks composing the Urals 4 principal structural levels and 4 noncontemporaneous systems of folding separated by stratigraphic breaks and angular unconformities.

The lowest level (Archean) may be regarded as the crystalline foundation for the overlying levels and as being identical with the crystalline basement of the Russian platform, but intensively fractured into blocks by abyssal fractures.

In plan the Uralian folded zone may be divided into a series of upwarps and downwarps bounded by deep fracture zones. These structures originated in the extensive Uralo-Siberian basin at the end of the Riphean time and continued to exist until the end of the Jurassic period.

A prominent role in the formation of the present tectonic aspect of the Urals was played by deep fractures and by the phenomenon of regeneration, which influenced sedimentation, volcanism, intrusive activity, and the formation of structures. --Auth. summ.

## 4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 3-2500; Paleontology 3-2603, 3-2604, 3-2605, 3-2616, 3-2617, 3-2619; Fuels 3-2799.

3-2542. Kummel, Bernhard. HISTORY OF THE EARTH; AN INTRODUCTION TO HISTORICAL GEOLOGY: 610 p., illus., maps, secs., diags., graphs, San Francisco, W.H. Freeman, 1961, refs.

This text is designed to give the student the proper background reading for nearly any course of lectures in historical geology. The introductory chapters outline the nature of the record, the methods of analysis, and the problems involved in the interpretation of the earth's history. The major theme of the remaining chapters is the interplay between mobile and immobile belts in the evolution of continents. The geologic history of each continent is presented, for each era, in terms of the changing spatial distribution of rocks,

and that changing distribution is related to the changing distribution and nature of ancient seas, to mountain-making movements, etc. Not every corner of the earth, obviously, can be mentioned in a text of this size, but the author has attempted to present enough wide-ranging material to give a balanced picture of the earth's history, at least since the Precambrian. The paleontological record of each era is discussed in terms of the evolution and distribution of faunas and floras and in relation to the physical history of the earth.

Even though the introductory chapters are more extensive than those in most texts on historical geology, the author regards them as the bare minimum that the student must have in order to understand how geologists interpret the earth's history. These chapters presuppose a thorough reading of a text on the principles of geology.

Students who have no familiarity with the major phyla of animals and plants will find a summary of them in Appendix I. Advanced students who wish to learn some of the formational names that are avoided in the text will find them in Appendix II. This consists of 23 correlation charts, each of which consists of 15 stratigraphic columns in which the major kinds of rock and the thickness of many formations are indicated. There are 2 charts for each geologic system, one for North America, the other for the remaining continents, and 1 chart is devoted to the Gondwana formations of the southern hemisphere.

In the illustrations the author has attempted to achieve a balanced geographic distribution. Maps, cross-sections, and sketches are emphasized because they generally tell more than photographs. The photographs that are used have been selected to illustrate the relations or the terrane of certain sites within the major continental areas.--From auth. pref.

**3-2543. American Commission on Stratigraphic Nomenclature. CODE OF STRATIGRAPHIC NOMENCLATURE:** Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 5, p. 645-665, May 1961.

The American Commission on Stratigraphic Nomenclature, recognizing the desirability of uniform usage in stratigraphic classification and terminology throughout the continent of North America, has proposed a new code of stratigraphic nomenclature. The prime purpose is 1) to formulate a usefully comprehensive, yet explicit statement of principles and practices for classifying and naming stratigraphic units, and 2) to secure the greatest possible uniformity in applying these principles and practices. This code is applicable to all kinds of rocks, sedimentary, igneous, and metamorphic. The Commission has been guided by the philosophy expressed in its reports on the nature, usage, and nomenclature of rock-stratigraphic, biostratigraphic, and time-stratigraphic units. The Articles of this code are recommendations that can not be generally mandatory, but geological organizations may adopt these articles as their rules of nomenclatorial procedure.

This code provides regulations and recommendations relating to 1) rock-stratigraphic units, 2) soil-stratigraphic units, 3) biostratigraphic units, and 4) time-stratigraphic units. The code also treats 2 categories of units that are not in themselves stratigraphic units but are closely related. These are 5) geologic-time units, which are fundamentally related in concept to time-stratigraphic units, and 6) geologic-climate units, which are based on Quaternary stratigraphic units.--From Preamble, Art. 1 & 2.

**3-2544. Lavrov, M. M. THE OSELKOVYE FORMATION:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 8, p. 90-92, pub. 1961, 5 refs.

In the northeastern part of eastern Sayan, in the basin of the Bolshaya Biryusa, Tagul, and Tuman-shet rivers, the ancient unmetamorphosed strata consist of 4 formations, one of which is the Oselkovoye - micaceous sandstones, shales, and thin-bedded quartzites about 4,000 m. thick. This formation has been referred to as the Oselkovoye formation and as the Oselchnoye formation.

It is revealed that the name Oselkovoye (used by A. Khomentovsky in 1950) was distorted to Oselchnoye by V. T. Mordovsky and others in 1953. Other geologists have relied on Mordovsky and also used the incorrect name. These men did not familiarize them-

selves with the original sources ("oselki" or whetstones, were made from the dense shales of this formation) and by their word making caused the incorrect name of the formation to appear in the "Stratigraphic Dictionary of the U. S. S. R." and in many professional and research reports. The author requests that a correction be made in the new edition of the Stratigraphic Dictionary and the formation be called "Oselkovoye" as demanded by priority and the origin of its name.--L. M. Dane.

**3-2545. Stepanenko, A. F. NEW DATA ON PRE-CAMBRIAN (SINIAN) AND LOWER PALEOZOIC DEPOSITS IN THE WESTERN PART OF THE KIRGHIZ RANGE (NORTHERN TYAN'-SHAN):** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 9, p. 58-70, 2 figs., pub. 1961, 15 refs.

New data are cited on the stratigraphy of the western terminus of the Kirghiz range (Tien-Shan) where Cambrian deposits were not known previously. The author's conclusions are based on the presence of a Middle and Upper Cambrian fauna in the Kirghiz range and on a study of the standard section embracing the upper part of the metamorphic complex (tentatively Sinian), most of the Cambrian, and lower half of the Ordovician. The author's data confirm the prevailing opinion on the consistency of lower Paleozoic sections within the N. Tien-Shan structural zone.

Starting from a comparison of sections of the Kirghiz range and the Charkalo-Narynsk zone, the author gives his interpretation of the distribution of the geosynclinal formations of the lower Paleozoic.--Auth.

**3-2546. Winder, C. G. LEXICON OF PALEOZOIC NAMES IN SOUTHWESTERN ONTARIO:** 121 p., Toronto, University of Toronto Press, 1961.

The purpose of this lexicon is to summarize the definition of all names which have been used in describing the Paleozoic stratigraphy of Ontario including the accepted, the controversial, and the invalid terms. The writer has attempted to present each unit objectively, although a subjective viewpoint had to be taken where some contention surrounded the application of a particular name. For this reason, this lexicon should not be cited as the authority for the use of a particular name. The references from which this text was compiled are listed, and the reader should consult these as the authoritative papers for the use of the name.

For each unit the Author is the person who originated the name whether its derivation was local or foreign. For those names from outside Ontario, the first author to apply the name in Ontario is usually cited under History. If the reader wishes to examine the formation as exposed at the surface, the first-mentioned or Type locality in Ontario is given for unit names derived locally. For those terms derived from outside the province, the best known Ontario exposure is listed as Reference locality along with an indication of the place from which the name was taken. It was felt that those who are sufficiently interested to see the type locality of formations outside Ontario will refer to the original description. The History has been included for those who may wish to review the use of the particular term. The lithologic descriptions have been abstracted from the most complete articles, supplemented with details which are considered useful in subsurface studies.--From auth. pref.



3-2547. Kozerenko, V.N., and A.A. Lokerman. LOWER SILURIAN DEPOSITS OF SOUTHEASTERN TRANSBAIKALIYA: Aka. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 8, p. 82-85, pub. 1961, 2 refs.

In summary, it may be noted that as a result of very detailed work it has been proved that the Nerchinsky-Zavod formation, widespread in southeastern Transbaikalia, is Lower Silurian (Wenlockian). It has been shown also that the attempt to "liquidate" this formation is not justified and would lead to a completely erroneous interpretation of the structures of the region. The age and position of the Blagodatsky formation have been determined, and this introduces a correction into the accepted stratigraphic section and adds to the knowledge of the history of the region in the Devonian period.

The discovery of faunas in the lower and upper limestone formations (Bystrinsk and Nerchinsky-Zavod formations, respectively) makes the lower Paleozoic section of the Nerchinsky-Zavod region of exceptional importance for the understanding of the structure of the lower Paleozoic rocks of southeastern Transbaikalia, and the section must be regarded as a type section.

This region, because of its economic importance, is covered by detailed geologic maps and has been studied by geologists over a long period of time. None of them has found any signs of disconformity in the lower Paleozoic section and all of them consider it as an uninterrupted section. Now it has been shown by the discovery of faunas that the section was deposited in the interval of time between the Lower Cambrian and Lower Silurian, inclusively. This indicates that the ideas of the absence of Ordovician deposits in southeastern Transbaikalia are groundless.

Inasmuch as the fossils of the Altacha formation date it within very broad limits, the lower Paleozoic formations may be indexed at present as follows: Bystrinsky - Cm<sub>1-2</sub>, Altacha - Cm<sub>2-0</sub>, and Nerchinsky-Zavod - O-S<sub>1</sub> Auth. summ.

3-2548. Shaver, Robert H., and others. STRATIGRAPHY OF THE SILURIAN ROCKS OF NORTHERN INDIANA: Indiana, Geol. Survey, Field Conf. Guidebook, no. 10, 62 p., 10 figs. incl. illus., maps, table, May 1961, 40 refs.

The Tenth Indiana Geologic Field Conference treats of the basic stratigraphy of the Silurian rocks that lie between the Cincinnati rocks and the bedrock surface in the rectangular area whose corners are defined by Sass, Allen, Randolph, and Hancock counties. The area forms part of the Tipton till plain and is mantled by Wisconsin tills of the Tazewell and Cary substages. Thus, well logs and cores are essential to an interpretation of the bedrock stratigraphy, but the 8 exposures in the itinerary nearly span the Niagara and Cayugan? series as known in Indiana.

Lowermost Silurian rocks, not exposed in the area, are assigned to the Brassfield limestone. Three principal post-Brassfield pre-Mississinewa stratigraphic units are here called "lower Niagaran rocks" and are thought to be correlatives of the Osgood formation and Laurel limestone, the Waldron shale, and the Louisville limestone of southern Indiana. These rocks are present at the bedrock surface in the southeastern and eastern parts of the conference area. Progressively younger rocks are found westward and northward and are assigned to the Mississinewa shale, the Liston Creek limestone, the Huntington

dolomite, and the Kokomo limestone.

The Huntington dolomite of common usage consists of lower Niagaran rocks, generally bedded, in the eastern and southeastern parts of the area and of upper Niagaran rocks, commonly reef facies, in the northern part. The so-called New Corydon limestone of Huntington County is in the upper part of the Niagaran, but the New Corydon type exposures in Jay County lie stratigraphically well below the Mississinewa shale.

The Kokomo limestone in its type area is assigned to the Cayugan, but its age and the unconformity that has been described at its base remain questionable. The rocks near Fort Wayne that have been called "Kokomo" are thought to be early-middle Devonian in age. They rest upon rocks of an upper Niagaran reef facies in the one exposure. Southeastward along the Silurian-Devonian contact in the western part of the area, Devonian rocks rest upon progressively older Silurian strata, and most of the Mississinewa and younger Niagaran rocks are absent from the southern part.

The historical development of stratigraphic terminology and the latest stratigraphic data suggest that the present usages of names for the following rock units in the conference area are less than satisfactory and that revision and redefinition may follow definitive study: Brassfield limestone, lower Niagaran rocks, Huntington dolomite, and New Corydon limestone.

Much of the fossil evidence bearing upon early correlations consists unsatisfactorily of species lists that had grown from author to author and through stratigraphic revisions. Many species, from non-typical exposures but presumably characterizing\* the faunal type, were added after stratigraphic identification had been made by means of lithostratigraphy; nearly half of the classic fossil localities are here assigned new stratigraphic positions. The fauna from the Mississinewa shale and younger Niagaran strata is thought to be Lockport and Guelph in age.--R.H. Shaver

3-2549. Andrichuk, John M. STRATIGRAPHIC EVIDENCE FOR TECTONIC AND CURRENT CONTROL OF UPPER DEVONIAN REEF SEDIMENTATION, DUHAMEL AREA, ALBERTA, CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 5, p. 612-632, 13 figs., May 1961, 7 refs.

In the Duhamel area of central Alberta, the Upper Devonian section under study comprises in ascending order: 1) Cooking Lake formation, 2) basal calcilitite of the Duvernay formation, 3) Leduc reef, and 4) Ireton formation. In off-reef sections, the Duvernay consists of basal calcilitites and argillaceous beds overlain by bioclastic limestones and an upper sequence of brown and black shales and calcilitites, overlain by the Ireton formation.

The Cooking Lake formation is composed mainly of pelletal (pseudo-oölitic) calcarenites and calcilitites formed probably by precipitation on a widespread bank. Calcarenites were concentrated along the western side of an interpreted shoal, the margin of which trended N. to NNE, approximately along the locus of later Leduc reef growth at Duhamel. The basal Duvernay calcilitite unit is less than 10 ft. thick above the Cooking Lake shoal, but increases in thickness abruptly to 50 ft. directly W. of the shoal margin. It is interpreted that these facies and thickness changes occurred along a tectonic hinge line caused by possible fault movement in the Precambrian basement that determined the locus of

later Leduc reef growth.

Leduc reef growth at Duhamel commenced essentially after the basal Duvernay calcilitite was deposited. Earliest or incipient patch-reef growth was confined to the relatively positive eastern side of the hinge line during latest Cooking Lake sedimentation. However, with differential subsidence along the aforementioned hinge line, the reefs grew laterally westward, overlapping the thickest section of basal Duvernay calcilitites, and the subsequent main reef buildup occurred on the interpreted down-warped, western side of the hinge line.

The bioclastic limestone unit of the Duvernay increases in thickness toward reefs, suggesting a derivation by erosion of actively growing reefs. The thickness distribution of bioclastic deposits indicates dominant currents from the NE. that transported a greater amount of debris to the southwestern (leeward) side of the reefs; however, thicker deposits at the SE. may have resulted from long-shore current transport southward along the fore-reef side.

During upper Duvernay deposition, increased subsidence resulted in mainly vertical reef growth and reduction in amount of reef erosion; only calcium carbonate and argillaceous muds accumulated more than 1 mi. away from the reef locus. The muds were deposited in relatively deep water, resulting in dark bituminous and partly laminated rocks with a sparse benthonic fauna. Brown and black shales accumulated in greater amounts in the more protected and stagnant waters SW. (leeward) of the reefs, and only in minor amounts as far as 10 mi. N. and E. of the Duhamel reef front.

In lower Ireton time, further increase in subsidence rate removed the restricting effects of the biohermal reefs and gray-brown and green-gray calcareous shales and calcilitites were deposited in off-reef areas. Reef growth was probably terminated during lower or middle Ireton deposition.

Facies and isolith maps of pertinent units in the Cooking Lake and Duvernay formations may be used as an effective new tool in the search for petroleum-bearing Leduc reefs in central Alberta.--Auth.

**3-2550.** Sable, Edward G., and J. Thomas Dutton, Jr. **NEW DEVONIAN AND MISSISSIPPIAN FORMATIONS IN DE LONG MOUNTAINS, NORTHERN ALASKA:** Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 5, p. 585-593, 4 figs., May 1961, 3 refs.

The Kuguruk formation, of Late Devonian age, consists largely of dolomite and limestone with minor shale, sandstone, and conglomerate, and is probably more than 2,000 ft. thick. The Mississippian Lisburne group is divided into 3 marine formations: the Utukok, Kogruk, and Tupik. The Utukok formation is at least 2,500 ft. thick at its type locality and consists mostly of ferruginous sandy limestone, calcareous and quartzitic sandstone, and calcareous shale. The Kogruk formation, as much as 1,500 ft. thick, is composed of thick-bedded, fine- to coarse-grained, gray limestone with minor beds and lenses of chert. The Tupik formation, as much as 700 ft. thick, is predominantly dark gray to black, finely crystalline limestone and black chert. Geographic distribution of these units is shown, and they are compared with the Devonian and Mississippian sequence in the Shainin Lake area, central Brooks Range. Other unnamed Devonian and Mississippian units in and near the De Long Mountains area are briefly described.--Auth.

**3-2551.** Hoover, Karl V. **DEVONIAN-MISSISSIPPIAN SHALE SEQUENCE IN OHIO:** Ohio, Div. Geol. Survey, Inf. Circ. no. 27, 154 p., 11 figs., 3 pls. 1960, refs.

The Devonian-Mississippian shale sequence in Ohio represents rock that is transitional between that of the Appalachian geosyncline and the midcontinent craton area, yet consanguineous to conditions of geosyncline sedimentation.

The paper is a summary of the geologic literature through 1955 which deals with this rock sequence in Ohio. It covers the following subjects: stratigraphy, paleontology, paleoecology, paleogeography, structural features, mineralogy, economic geology, and "the black shale problem."

The appendix consists of 2 sections: a) annotated bibliography of 480 references, and b) uncorrected fossil list catalogued according to unit or units in which some 990 species have been identified.--Auth.

**3-2552.** Fuzesy, L. M. **CORRELATION AND SUBCROPS OF THE MISSISSIPPIAN STRATA IN SOUTHEASTERN AND SOUTH-CENTRAL SASKATCHEWAN:** Saskatchewan, Dept. Mineral Resources, Rept. no. 51, 63 p., 12 figs., 11 pls. (in pocket), 3 tables, 1961, 18 refs.

The area examined is located in southeastern and S.-central Saskatchewan on the northern flanks of the Williston basin. Mississippian strata in the area consist mainly of limestones and dolomites with several interbedded evaporite beds in the upper part of the succession. Lower evaporites occur near the northeastern margin of the basin, but these die out toward the basin center. Successively higher evaporites each have a wider extent, and those in the Poplar beds are present throughout the extent of these beds. Post-Mississippian erosion truncated the southerly dipping Mississippian strata so that basinward, higher and higher Mississippian members are present.

At the present time these Mississippian rocks are the most important oil-producing strata in Saskatchewan. The oil reservoirs occur in porous limestones or dolomites. Caprocks on the reservoirs may be divided into 3 categories: 1) primary evaporites and occasionally nonporous, impermeable argillaceous beds, interbedded in the Mississippian carbonate sequence; 2) dense, nonporous layers at the erosion surface, resulting from infilling of the porosity of previously porous, permeable rocks by secondary anhydrite and occasionally chert; 3) argillaceous beds of the overlying lower part of the Watrous formation of Jura-Triassic age. Combinations of these types of caprocks occur at some localities.--Auth.

**3-2553.** Grayzer, M. I. **NEW DATA ON LOWER CARBONIFEROUS STRATIGRAPHY AND LITHOLOGY OF TUVA:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 9, p. 41-57, 2 figs., pub. 1961, 6 refs.

New paleontologic and lithologic data are cited for a more detailed differentiation and refinement of the composite stratigraphic scheme for the lower Carboniferous of Tuva. Six formations are recognized: Suglugkhem, Kyzylchirin, Kherbes, Baytag, Ekki-Ottug, and Aktal, ranging from Tournaisian through Viséan.--M. Russell.

**3-2554.** Duane, David B. **HEAVY-MINERAL SEGREGATION IN SPRINGER SANDSTONES IN ANA-**



**ARKO AND ARDMORE BASINS, OKLAHOMA:** Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 4, 556-560, 3 figs., table, Apr. 1961, 7 refs.

About 200 heavy-mineral slides were studied representing about 2,000 ft. of sandstone collected from 8 vertical sections through Springer sandstones [Lower Pennsylvanian] along a 70-mi. cross-section. This cross-section runs northward from the Ardmore basin into the Anadarko basin. Except for the segregation of topaz and staurolite, the heavy minerals obtained are monotonously similar; they are predominantly rounded stable detrital minerals derived from preexisting sediments.

During deposition of the Springer sandstones, the Anadarko-Ardmore basin was divided into a northwestern and a southeastern basin. The northwestern basin is characterized by the presence of topaz and almost total absence of staurolite, whereas the southeastern basin is characterized by the presence of staurolite and absence of topaz. Sediments in the northwestern basin were derived in part from a southern source, while a metamorphic source area on the SE. contributed to sediments in the southeastern basin.--F. E. Kottlowski.

**3-2555. Westheimer, Jerome M. NOTES ON THE HARTSHORNE SANDSTONE:** Oklahoma Geology Notes, v. 21, no. 2, p. 50-51, Feb. 1961.

The Hartshorne sandstone [Pennsylvanian] is recognized on surface and in subsurface in the Ardmore basin. The unit lies below the Lester limestone, which therefore belongs to the Big Branch formation of the Des Moines series.--C. C. Branson.

**3-2556. Vyltsan, I. A. COMMENTS ON THE 1956 UNIFIED STRATIGRAPHIC SECTION OF THE COAL-BEARING DEPOSITS OF THE KUZBAS:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 8, p. 86-90, 3 figs., pub. 1961, 10 refs.

A new detailed and unified diagram of the stratigraphy of carboniferous deposits of the Kuzbas was accepted at the conference in Leningrad in 1956. The author considers that this diagram does not sufficiently reflect the composition of barren suites of the basin. Subdivision of these suites must be made more accurately.--From LC.

**3-2557. McGugan, Alan. REVISION OF UPPER PALEOZOIC NOMENCLATURE, BANFF AREA, ALBERTA, CANADA:** Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 4, p. 548-550, sec., Apr. 1961, 10 refs.

The succession at Highwood Pass was previously misinterpreted. The "Storm Creek formation" is directly overlain by Norquay beds containing early Middle Pennsylvanian fossils, and is underlain by clastic rocks bearing Morrowan fossils. It is equivalent to the type Tunnel Mountain formation. The "Norquay formation" is not equivalent to the type Norquay but corresponds to the Todhunter member of the Tunnel Mountain clastic rocks. The "Tunnel Mountain formation" is not equivalent to the type Tunnel Mountain, but is typical carbonate rocks of the Etherington formation with a high Chesteran fauna. Thus the "Stenopora zone" is not Permian in age but Lower Pennsylvanian, and the "Plagioglypta canna zone" as shown by fusulinids is early Middle Pennsylvanian in age, not Permian.

The Rocky Mountain group is divided into 3 for-

mations. From the top down these are: the Ishbel formation (new name) of Permian age, the Kananaskis formation (new name) of early Middle Pennsylvanian age, and the Tunnel Mountain formation (restricted) of Lower Pennsylvanian age, which includes Tunnel Mountain clastic rocks only.--F. E. Kottlowski.

**3-2558. Jordan, Louise. LPG STORAGE IN FLOWERPOT SALT, BEAVER COUNTY, OKLAHOMA:** Oklahoma Geology Notes, v. 21, no. 2, p. 34-35, fig., Feb. 1961, 2 refs.

In the construction of an underground LPG(liquified-petroleum-gas)-storage facility, cores were taken from 723 to 1,098 ft. in Permian rocks. Below 13 ft. of Dog Creek shale, the Blaine formation from 736 to 840 ft. consists of 7 anhydrite strata interbedded with shale, and is underlain by 26 ft. of gray Flowerpot shale. Underlying the shale, relatively pure salt occurs from 866 to 1,030 ft. The lowermost 68 ft. of section contain salt with a shale content ranging from 10 to 60%. Salt is found in the Flowerpot in the subsurface under a large area of northwestern Oklahoma and in the Oklahoma Panhandle.--Auth.

**3-2559. Stafford, Philip T. STRATIGRAPHY OF THE WICHITA GROUP IN PART OF THE BRAZOS RIVER VALLEY, NORTH TEXAS:** U.S. Geol. Survey, Bull. 1081-G, p. 261-280, map, 2 pls. (in pocket), incl. col. geol. map, scale 1:125,000, 1960, 33 refs.

Rocks composing the Wichita group (Permian) crop out in Texas in a N.-southward-trending area extending from the Red River on the Oklahoma-Texas border to the Llano uplift in central Texas. The outcrop area of the Wichita group discussed in this report lies in the southern part of the Brazos River drainage basin, extending from central Callahan and Eastland counties northward to central Throckmorton and southwestern Archer counties.

Most rocks in the mapped area belong to the Wichita group, which includes about the lower half of the rocks of the Leonard series (Permian) and all of the rocks of the Wolfcamp series (Permian). The group consists of 7 units, which are, in ascending order: the Pueblo, Moran, Putnam, Admiral, Belle Plains, and Clyde formations, and the Uueders limestone. Each formation is divided into as many as 6 members.

Gray and red shale predominate in the Wichita group, but limestone, sandstone, siltstone, conglomerate, and coal are also present. Most of the sandstone and conglomerate forms lenticular, channel-fill deposits. The thickness of the group ranges from 1,550 to 1,800 ft.; locally, channel deposits near the base increase the thickness as much as 200 ft.

The lithology of the Wichita group gradually changes from central to N. Texas. In the Colorado River valley area in central Texas, a marine shale and limestone facies predominates. Northward, the marine beds decrease in number and red beds become predominant. In N. Texas, near the Red River, most of the section is composed of a marginal marine red-bed facies of shale and sandstone.

Rocks of the Cisco group (Pennsylvanian), Clear Fork group (Permian), and Trinity group (Cretaceous), and Quaternary alluvium and terrace deposits also are present in the mapped area.

The outcropping Pennsylvanian and Permian strata have a regional dip of less than 1° to the WNW. In southern Throckmorton County an E.-W. line of northwestward-trending faults is exposed. The

Cretaceous rocks seem to have been less deformed than the Paleozoic rocks.--Auth.

**3-2560.** Jefferson, C. C., Jr., and G. R. Pierce. **PRECIS OF MESOZOIC "REDBEDS" NEAR CARACHE, TRUJILLO, VENEZUELA:** *Am. Assoc. Petroleum Geologists, Bull.*, v. 45, no. 3, p. 390-391, fig., March 1961, 8 refs.

The most northeasterly exposure of the La Quinta formation, of Triassic to Jurassic age, is near Carache and consists of conglomeratic sandstones, pebble to boulder conglomerates, and red shales; thickness totals 150 m. The conglomerates contain pebbles derived from the underlying Paleozoic Palmarito formation. Red beds previously placed in the La Quinta formation NE. of Carache, near San Pedro, El Tocuyo, and Curarigua in the state of Lara, are actually part of the Río Negro formation of Cretaceous age. Interbedded with these latter red beds are red-colored conglomerates and brown quartzitic sandstones and siltstones; no Palmarito fragments were observed in the Río Negro conglomerates. Near Carache black shales also occur in the Río Negro formation which is 1,300 m. thick near Páramo Céndé. In other places in the Mérida Andes, the Río Negro formation is found unconformably overlying the La Quinta formation or rocks of Carboniferous to Permian age; it is overlain conformably by the Aptian Apón formation.

Based on plant fossils and stratigraphic position, the Río Negro formation near Carache is considered Neocomian to basal Aptian in age; it consists of interbedded dumped, continental facies and well-bedded, shelf facies that had been grouped as part of the Peñas Altas formation.--F. E. Kottlowski.

**3-2561.** Konivets, V. I. **THE HEAVY FRACTION MINERALS FROM THE ALDAN-OKEKMA WATERSHED:** *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 9, p. 82-84, pub. 1961, 5 refs.

Heavy mineral assemblages of the coal-bearing rocks of the Aldan-Olekma watershed confirm earlier classification of the rocks into named formations and shows their usefulness in correlating sections of the S. Yakutian and adjacent Mesozoic troughs. The most common heavy minerals are iron hydroxides, pyrite, zircon, apatite, garnet, rutile, octahedrite, sphene, leucoxene, the epidote-zoisite group, and biotite.--M. Russell.

**3-2562.** Malyutina, Z. A. **ON THE SEPARATION OF THE MAMYT FORMATION IN THE CONTINENTAL JURASSIC DEPOSITS OF THE EASTERN SLOPE OF THE SOUTHERN URALS:** *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 8, p. 64-71, map, pub. 1961, 5 refs.

Jurassic continental deposits are widespread on the eastern slope of the southern Urals between 50° 12'-52° 15' N., and 58° 0'-59° 10' E. The whole region can be considered as an interior basin and is associated with the southern sinking of the Magnitogorsk synclinorium. It includes many parts of the synclinorium complicated by tectonic movements and forms a series of smaller depressions. The whole Orsk series is divided into 3 suites: the Khaybulino, the Mamyt and the Ziren-Agach suites. The Khaybulino suite is associated with siderite - argillaceous Fe and brown coal deposits. By the remains of flora and by numerous spores and pollens, the age of this suite is Aalenian of the Middle Jurassic. The

Mamyt suite is a local subdivision of the Orsk series. Both these suites belong to the same limnic meso-cycle forming 2 rhythmic cycles, but, whereas the Khaybulino suite is associated with a transgressive sedimentary cycle, the Mamyt suite is characterized by a slowed process of sinking, and correlations of its facies is quite different from that of the Khaybulino suite. It includes whole horizons of brown coals and is the main coal-bearing suite of the basin.

There were many more varieties of fossil plants in the Mamyt suite than in the Khaybulino suite, which also indicates a sharp change in paleoclimatic conditions. The author gives a detailed description of the tectonic structures of both suites and their lithological and paleontological characteristics. The Ziren-Agach suite which overlies the Mamyt suite belongs to a new sedimentary cycle connected with uplift of the Paleozoic rocks in the northern part of the Orsk basin. It is composed of conglomerates and of coarse-grained sands. Pollen and spore analysis indicates that the Ziren-Agach belongs to the upper part of the Middle Jurassic.--From L.C.

**3-2563.** Dmitrieva, R. G., and others. **THE ALKUN ZONE AND ITS STRATIGRAPHIC SIGNIFICANCE:** *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 8, p. 72-81, 3 figs., pub. 1961, 7 refs.

The authors propose the unification of numerous local stratigraphic schemes of subdivision of the Maikop series (Oligocene-Miocene) of eastern Ciscaucasia into suites and horizons, taking as a basis for this unification the Alkun horizon, which was identified in different regions of eastern Ciscaucasia, between the rivers Sulak in the E. and Belaya in the W. The authors give the characteristic features of the Alkun horizon and its correlation with over- and underlying beds in each of the 7 regions studied. The Maikop series have been subdivided into suites and horizons.

The authors studied 7 different core-samples identifying the Alkun horizon in each of them. An analysis of these core-samples showed that the Alkun horizon is composed of clays of various colors with carbonaceous inclusions differing in structure and composition. The most important feature of the horizon is the presence of a resistant lithological complex called by the authors an argillaceous-dolomitic platy bed with *Cystoseira*. This bed of platy dolomites with enclosing clays contains (in most of the core samples) the imprints of weeds of the *Cystoseira* species, characteristic of the Alkun. It also contains remains of the Foraminifera *Uvigerinella* aff. *californica* Cushman, *Bolivina* ex gr. *floridana* Cushman, and *Nonion* aff. *martkobi* Bogd. The authors think that the Alkun horizon can be used as a correlative for geological mapping and as a basis for a unified stratigraphic plan of the Maikop series.--From L. C.

**3-2564.** Harksen, John C., and others. **NEW MIOCENE FORMATION IN SOUTH DAKOTA:** *Am. Assoc. Petroleum Geologists, Bull.*, v. 45, no. 5, p. 674-678, 3 figs., May 1961, 3 refs.

A distinctive new stratigraphic unit, herein named the Sharps formation, occurs conformably between the underlying Brule formation of the Oligocene White River group and the overlying Monroe Creek formation of the Miocene Arikaree group. The formation is named for exposures near Sharps Corner in Shannon County, southwestern South Dakota, and



consists of 390 ft. of massive tan silt and volcanic ash. The basal volcanic ash bed is called the Rockyford ash, as much as 38 ft. thick. Amid the silt beds are scattered small calcareous "potato-ball" concretions, impure gastropod-bearing limestones, clastic and chaledony dikes, channel sands and gravels, and algal limestones. The formation has been traced eastward 50 mi. or more, and southwestward for 75 mi. to near Harrison, Nebraska. The stratigraphic position of the Sharps formation is similar to that of the basal, channel-fill Gering formation of the Arikaree group in that both underlie the Monroe Creek formation directly, but the lithologic characteristics are dissimilar. The age of the Sharps formation appears to be very early Miocene, based on a vertebrate fauna that includes 17 genera and 25 species.--F. E. Kottlowski.

3-2565. Mackay, J. Ross, and others. **GEOLOGY OF THE ENGIGSTCIAK ARCHAEOLOGICAL SITE, YUKON TERRITORY:** Arctic, v. 14, no. 1, p. 25-52, 10 figs., 2 tables, March 1961, 37 refs.

The common succession of layers at the archeological site - marine clay overlain by terrestrial organic matter with artifacts, and this by more marine clay, which extends to the surface soil - can not be accepted as a stratigraphic sequence representing 2 marine invasions, with intervening and succeeding periods of emergence. The evidence suggests only a single marine invasion, coincident with an advance of glacier ice. The marine invasion may not have reached the present altitude of the archeological site, but instead the marine beds laid down during this invasion may have been thrust up by glacier ice into their present position on the NE. slope and the crest of the Engigstciak plateau. Here, as a result of movements within the surface soil brought about by freezing and thawing and by down-slope creep, organic matter and artifacts have been subsequently incorporated into the clay as a more or less distinct layer at the base of the active layer. Some marine clay has in all probability moved down the SW. slope of the plateau, where it has come to rest on a sand deposit, which originated independently. The marine clay together with surface vegetation and archeological remains has lately been incorporated into the sand.

From these conclusions about the geological origin of the soils, it follows that all artifacts and associated organic detritus in the clay areas of the site postdate the last glaciation of this area, whatever this may correspond to in the classical Pleistocene successions of more temperate latitudes. Artifacts found in the sands of the southwestern part of the site are probably also postglacial, although there the relationship is less clear. In any event, it is also concluded that in the clay areas of the crest of the plateau the depth at which the artifacts are now found has very little significance, except that there was time and opportunity for older remains to become more deeply buried than younger ones. In the sandy areas of the S. slope the evidence of disturbance is clear in the upper horizons, and a buried muck layer occurs on the higher slopes. There also invasion may have taken place and the depth of the artifacts may have little age significance. In the Buffalo Pit, however, both the gradational contact between the humic sands and the underlying streaky sands, and the sharp contact between the streaky sands and the underlying yellowish sand are relatively free from disturbance, with no signs of involutions. It appears, therefore, that the artifacts,

bones, and pollen from the humic sands have not been derived from the underlying streaky and yellowish sands, and vice versa. It seems reasonable that there the artifacts, etc., from the humic sands are younger. Elsewhere at this site the archeological complexes will have to be dated and correlated on archeological considerations or by C-14 analyses of animal remains, mainly bones and teeth, or of charcoal, rather than of coincidentally associated plant matter.

Although the geological investigations have provided no significant help in dating the archeological remains, the archeological material has proved invaluable in the study of the more complex soil movements, hitherto very poorly understood, which take place in this arctic environment.--Auth. summ.

3-2566. Lemon, R. R. H., and C. S. Churcher. **PLEISTOCENE GEOLOGY AND PALEONTOLOGY OF THE TALARA REGION, NORTHWEST PERU:** Am. Jour. Sci., v. 259, no. 6, p. 410-429, fig., table, June 1961, 14 refs.

Three major erosion surfaces (tablazos) and associated deposits of Pleistocene age in coastal northwestern Peru are described. The marine deposits are richly fossiliferous; the Mancora (oldest) and Talara tablazo faunas are of cooler-water type, the Lobitos (youngest) fauna is similar to that of the modern shoreline.

A terrestrial vertebrate fauna from tar seep deposits on the Mancora tablazo is similar to that of the Carolinian of Ecuador. A provisional list of the Talaran fauna is compared with faunas from the Carolinian of Ecuador and from Rancho La Brea, California.

It is likely that the local climatic regime of the coastal plain differed little from that of the present day. However, the tar seep fauna suggests an at least moderately abundant water supply, probably provided by permanent or semi-permanent streams rising in a wetter hinterland.--Auth.

3-2567. Khoreva, I. M. **NEW DATA ON THE STRATIGRAPHY OF QUATERNARY DEPOSITS IN THE ALDAN RIVER VALLEY:** Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 9, p. 71-79, 3 figs., pub. 1961, 10 refs.

Variations in the thickness of Tertiary deposits along the Aldan river indicate Tertiary subsidence along the lower course and uplift and increased downcutting along the upper course. Cessation of subsidence and deposition from intensive aggradation marked the Pleistocene. A terrace from 11 to 15 m. high was formed during the upper Pleistocene along the middle and upper Aldan. Fossil rodents, grasses, and woody plants indicate tundra and forest-tundra conditions during the Pleistocene.--M. Russell.

3-2568. Kulp, J. Laurence. **GEOLOGIC TIME SCALE:** Science, v. 133, no. 3459, p. 1105-1114, chart, 3 tables, Apr. 14, 1961, approx. 40 refs.

A new geologic time scale is presented based on superior dating of 88 critical samples. The geological situation of each sample is described briefly. The locality, rock type, mineral, and method used in the dating, calculated age, and literature references are given. Recent advances in dating techniques make this time scale more reliable than previous ones: for example, the Lower-Middle Devonian

boundary is dated at 390 + 5 million years ago. Comparison with previously proposed time scales indicates generally good agreement. The subdivision of the Cenozoic is especially accurate; good dates are still lacking for the lower Paleozoic. Errors inherent in sample selection and analysis are discussed.--F. P. Glasser.

3-2569. Afanasev, G. D. SOME GEOLOGIC RESULTS OF STUDY OF THE ABSOLUTE AGE OF ROCKS: Akad. Nauk SSSR, *Izvestiya, Geol. Ser.*, in translation, 1959, no. 9, p. 7-14, pub. 1961, 11 refs.

Knowledge of the absolute age of rocks is important in problems of petrogenesis and ore formation. The most accurate method is a combination of the Ar and Sr methods. Age determinations are listed for the Precambrian of the Ukraine, Precambrian and Mesozoic of the Urals, and various ages of the Caucasus, Central Asia, central Kazakhstan, Transbaikalia, Soviet Far East, and selected non-Soviet countries.--M. Russell.

3-2570. Komlev, L. V., and others. POTASSIUM-ARGON AND LEAD AGES OF SOME GRANITES AND PEGMATITES OF THE MIDDLE DNEPR REGION: *Geokhimiya*, in translation, 1959, no. 2, p. 133-140, 4 tables, pub. 1960, 12 refs.

New age data is presented, obtained by the K-Ar method on micas separated from some of the granites and pegmatites of the middle Dnepr region, U.S.S.R., and by the isotopic Pb methods on the accessory monazites and allanites from pegmatite dikes. The results of age determinations are presented in tables. New decay constants of  $K^{40}$  give K-Ar ages higher by 7 to 8%, and this brings the results of the Ar method closer to those obtained by the isotopic Pb methods.

An unusually high age of 2,900 million years was

obtained for biotite from a pegmatite cutting granodiorite of the Yamburg quarry on the Mokraya Sura river. The ages obtained for the plagioclase-rich granites of the Saksagan River (quarry near the village of Ternovatyi Kut) and the Kremenchug granodiorites (Kryukov and Chikalov quarries) range from 1,900 to 2,700 million years. Very high ages of the Korbino pegmatites have been established by 2 independent methods. The Tokovo granite is between 1,770 and 1,930 million years.--M. Russell.

3-2571. Boucot, Arthur J. STRATIGRAPHY OF THE MOOSE RIVER SYNCLINORIUM, MAINE: U.S. Geol. Survey, Bull. 1111-E, p. 153-188, 3 figs., col. geol. map (in pocket), scale 1:250,000, 1961, 20 refs.

The Moose River synclinorium of W.-central Maine contains the greatest thickness of relatively unmetamorphosed upper Lower Devonian strata known in the Appalachian belt. These strata, which have a total average thickness of about 10,000 ft., are chiefly dark sandstone and slate, with subordinate amounts of rhyolite. Strata of Oriskany and early Onondaga age form the trough of the synclinorium. On the flanks of the synclinorium they are unconformably underlain by erosional remnants of Helderberg, Late Silurian, possible Silurian(?), Middle Ordovician, Cambrian or Ordovician, and possible Precambrian age. The strata of Silurian through Helderberg age consist chiefly of calcareous sandstone, calcareous siltstone, conglomerate and arkose containing granitic and volcanic debris, limestone conglomerate, and limestone, with a maximum thickness of about 4,000 ft. The pre-Silurian strata consist of light and dark volcanic rocks, slate, phyllite, dark sandstone, graywacke, gneiss, and granitic rocks, with unknown stratigraphic thicknesses. Intrusive rhyolitic rocks of Early Devonian age and intrusive granitic rocks of post-Early Devonian age are present. The granitic intrusive rocks are bordered by contact metamorphic aureoles.--Auth.

## 5. PALEONTOLOGY

See also: Stratigraphy 3-2551, 3-2566.

3-2572. Abelson, Philip H. EXTRA-TERRESTRIAL LIFE: *Natl. Acad. Sci., Proc.*, v. 47, no. 4, p. 575-581, Apr. 1961, 22 refs.

It is quite unlikely that terrestrial-like life exists on the moon, Venus, or Mars. It is virtually impossible to contaminate these bodies by organisms carried from earth along with space devices.

One cannot be so certain that no life exists on Venus or Mars. If it is present, its detection will probably require methods other than those employed in microbiological laboratories. Successful meeting of the new challenges of space biology will demand a more imaginative, sophisticated approach than has been evident so far. Needed in the immediate future is a more solid base of certain and detailed information concerning the planetary environments. Of first priority are determination of a more certain value of the surface temperature of Venus and the composition of the atmosphere of Mars, especially water, C, and N compounds.--Auth. summ.

3-2573. Galloway, J. J., and Joseph St. Jean, Jr. ORDOVICIAN STROMATOPOROIDEA OF NORTH AMERICA: *Bulls. Am. Paleontology*, v. 43, no. 194, 102 p., 13 pls., 1961, 97 refs.

Ten genera and 37 species of North American Ordovician stromatoporoids, all in the family Labechiidae, are described and figured, including 10 new species.--Auth.

3-2574. Minato, Masao. EINE PERMISCHE KORALLE VON KÖNIG OSCARSLAND IM NORDWESTLICHEN ELLESMERELAND [A Permian Coral from King Oscar's Land in northwestern Ellesmere Land]: *Stockholm, Univ., Stockholm Contr. Geology*, v. 6, p. 25-36, illus. incl. map, 1960; text in German, summ. in English.

A reexamination is made of a massive coral collected by P. Schei from Big Bear Cape (Store Björnekap), King Oscar's Land on Ellesmere Island, and described by Tschernyschew and Stepanow under the name of *Lithostrotion borealis* (Stuckenborg).

The specimen appears to be different from typical Carboniferous specimens of *L. borealis*; a closer resemblance is seen to *Ipciphyllum ipci* Hudson and *I. subtimorica* (Huang), both of which are Permian species. However, the specimen may be distinguished from these 2 species in having very thin septa and a more simple columellar structure. The name *Ipciphyllum tschernyschewi* is, therefore, proposed.

The strata which contained this coral may be



correlated with the Permian *Parafusulina* zone of Thompson, rather than with the upper Carboniferous as Stepanow believed. The brachiopod fauna found in association with the coral also indicates a much later age than supposed by Stepanow.--Auth.

3-2575. Reimann, Irving G., and Robert O. Fay. POLYDELTOIDEUS, A NEW SILURIAN BLASTOID FROM OKLAHOMA: Oklahoma Geology Notes, v. 21, no. 3, p. 86-89, pl., March 1961, 3 refs.

The new Silurian blastoid genus *Polydeltoideus*, from the Henryhouse [Silurian] shale of Pontotoc County, Oklahoma, has 6 anal deltoid plates, a superdeltoid, 2 unnamed deltoids resting upon the aboral face of the superdeltoid on either side of the anal opening, with 2 paradeltoide plates resting on these, and a large hypodeltoide resting on the unnamed deltoids adjacent to the radial limbs and aboral to the paradeltoide. The theca is steeply conical, with hydrosphere slits (3-10) on either side of each ambulacrum, reduced in the anal area, and the lancet is covered by the side plate. The type species is *P. enodatus* Reimann and Fay, and is considered one of the most primitive known blastoids. The type specimens are on deposit in the Museum of Paleontology, University of Michigan.--R. O. Fay.

3-2576. Fay, Robert O. THE TYPE OF DEVONOBLASTUS REIMANN 1935: Oklahoma Geology Notes, v. 21, no. 4, p. 110-112, pl., Apr. 1961, 3 refs.

The 3 type specimens of *Devonoblastus* Reimann, 1935, named *Pentremites* Ieda Hall, 1862, are on deposit at the New York State Museum, Albany, New York. These 2 cotypes and 1 hypotype were never illustrated or described in detail, until now. The specimens were collected from the Devonian Hamilton group, western New York.--Auth.

3-2577. Fay, Robert O. THE TYPE OF TRICOELOCRINUS MEEK AND WORTHEN: Oklahoma Geology Notes, v. 21, no. 3, p. 90-94, 3 figs., pl., March 1961.

The type specimen of the type species of the Mississippian blastoid *Tricoelocrinus*, named *Pentremites* (*Troostocrinus*) *woodmani* Meek and Worthen, 1868, is on deposit in the American Museum of Natural History. Of importance is the fact that there are 4 anal deltoid plates on the anal side. The type specimen came from the Keokuk limestone, Salem, Indiana.--Auth.

3-2578. Fay, Robert O. DELTOBLASTUS, A NEW PERMIAN BLASTOID GENUS FROM TIMOR: Oklahoma Geology Notes, v. 21, no. 2, p. 36-40, 2 pls., Feb. 1961, ref.

The genus *Deltoblastus*, with type species *D. elongatus* (Wanner), is proposed for the Permian species of *Schizoblastus* from Timor Island. The genus is similar to *Schizoblastus* but differs in several aspects: 1) the radials overlap the deltoids, 2) the lancet is almost fully exposed, and 3) the deltoid septa extend into oral crests. These features are not present in *Schizoblastus*. A key to 15 species is given, translated from Wanner.--Auth.

3-2579. Strimple, Harrell L., and W. T. Watkins. ON SYNATHOCRINUS? ANTIQUUS: Oklahoma Geology Notes, v. 21, no. 2, p. 48-49, 2 figs., Feb.

1961, 2 refs.

A crinoid species from the Henryhouse formation [Silurian], thought to represent a stage between *Ectenocrinus* and *Synbathocrinus*, possesses divided, although ankylosed, plates in the right posterior, left anterior, and anterior rays of the dorsal cup.--Auth.

3-2580. Strimple, Harrell L. THE GENUS PARAGASSIZOCRINUS IN OKLAHOMA: Oklahoma Geol. Survey, Circ. 55, 37 p., 2 figs., 3 pls., 1960, 16 refs.

The fused infrabasal cones of the crinoid *Paragassizocrinus* are preserved in greater numbers than hard parts of many fossils. Differences in the shape of the conical cup and in the upper facets of the infrabasal plates permit differentiation of species. Ten species, 8 of which are new, occur in the Pennsylvanian rocks of Oklahoma, and these species are useful in determining geologic age of the beds in which they occur.--Auth.

3-2581. Utgaard, John, and T. G. Perry. FENESTRATE BRYOZOANS FROM THE GLEN DEAN LIMESTONE (MIDDLE CHESTER) OF SOUTHERN INDIANA: Indiana, Geol. Survey, Bull. no. 19, 32 p., 12 figs., 6 pls., 1960.

Fenestrate bryozoans are particularly abundant in shale and argillaceous limestone beds in the upper part of the Glen Dean limestone (middle Chester) of late Mississippian age in S.-central Indiana. Several hundred specimens were obtained from 2 excellent collecting localities in Perry County and from one exposure in northwestern Crawford County. The collected specimens are assigned to the genera *Fenestella* Lonsdale, *Lyroporella* Simpson, and *Polypora* McCoy of the family *Fenestellidae* King and to the genus *Septopora* Prout, a member of the family *Acanthocladiidae* Zittel. *Fenestella* is the most abundantly represented genus in our collections and includes 5 species, *Fenestella burlingtonensis* Ulrich, *F. cestriensis* Ulrich, *F. exigua* Ulrich, *F. matheri* Condra & Elias, and *F. tenax* Ulrich. *Polypora* is the next most abundant genus and is represented in the fauna by 3 species, *Polypora corticosa* Ulrich, *P. multispinosa* McFarlan, and *P. nodolinearis* McFarlan.

Frequency-distribution diagrams showing number of branches and fenestrules in a 10-mm. distance and number of zooecia and nodes in a 5-mm. distance have been prepared for each described species except *Septopora cestriensis* Prout; only one specimen of this species displays the obverse side of the frond. Such diagrams permit clearer differentiation of closely allied species in which ranges of one or more structural characters may overlap, and these diagrams present a more accurate understanding of each species.

The Glen Dean fenestrate bryozoan fauna, exclusive of *Archimedes* Owen, which is not treated in this study, includes 11 species. Although fenestrate bryozoan faunas have been described in considerable detail from Glen Dean beds in Illinois and Kentucky, these faunal elements of the Glen Dean of Indiana hitherto have not received significant attention.--Auth.

3-2582. Branson, Carl C. RETICULATIA IN THE BELLE CITY LIMESTONE: Oklahoma Geology Notes, v. 21, no. 4, p. 128, fig., Apr. 1961, 2 refs.

The productid genus *Reticulatia* Muir-Wood and

Cooper, 1960, has been found in the Belle City limestone [Pennsylvanian] in Seminole County, Oklahoma. The genus had earlier been recorded in Virgilian and Early Permian rocks. The range is extended downward into the Missourian by the present specimens.--Auth.

3-2583. Fay, Robert O. PERMOPHORUS CHAVAN, 1954, A NEW NAME FOR PLEUROPHORUS KING, 1848: Oklahoma Geology Notes, v. 21, no. 3, p. 89, March 1961.

The common Permian clam *Pleurophorus* King, 1848, is incorrectly named because the name is preoccupied by *Pleurophorus* Mulsant, 1842. The formal name-change of the junior homonym to *Permophorus* was made by Andr  e Chavan in *Cahiers g  ologiques de Thoiry*, no. 22, p. 200, Jan. 1954.--Auth.

3-2584. Olsson, Axel A. MOLLUSKS OF THE TROPICAL PACIFIC, PARTICULARLY FROM THE SOUTHERN HALF OF THE PANAMIC-PACIFIC FAUNAL PROVINCE (PANAMA TO PERU). PANAMIC-PACIFIC PELECYPODA: 572 p., 86 pls., Ithaca, New York, Paleontological Research Institution, 1961, refs. (not seen at AGI).

The work deals with the Recent Pelecypoda of the southern half of Panamic-Pacific zoogeographic province. A historical review is included consisting of the period from the French Mission (1735-1744) through that of the New York Zoological Society (1937-1938), Templeton Crocker Expedition, 1936. Details concerning the work of Humboldt, D'Orbigny, Darwin, Hugh Cuming, the voyages of the *Astrolabe*, *La Bonite*, *Sulphur*, and *Albatross* as well as that of C. B. Adams, Philip Carpenter, and modern workers. The general geographical, geological, and zoological features of the coast of Panama to northwestern part of Peru are described. Details of the mollusks of the faunal provinces are included. Keys to families, genera, and species are provided. Specimens have been compared with types. Thirty new genera or subgenera with 75 new species or subspecies are described.--K. V. W. Palmer.

3-2585. Unklesbay, A. G. A LARGE PENNSYLVANIAN ORTHOCONE FROM OKLAHOMA: Oklahoma Geology Notes, v. 21, no. 4, p. 108-110, fig., Apr. 1961, ref.

A well-preserved specimen of *Mooreoceras normale* Miller, Dunbar, and Condra, in the collections of the University of Tulsa, is one of the largest specimens known, measuring 455 mm. in length. Theoretical reconstruction of the missing portion indicates that the orthocone was originally nearly 700 mm. long. The specimen comes from the Fort Scott limestone [Pennsylvanian], E. of Tulsa.--A. Nicholson.

3-2586. Lehmann, Ulrich. SALTERSCHE EINBETTUNG BEI OGYGOPSIS WALC (TRIL.) IM MITTEL-KAMBIUM VON BRITISCH-COLUMBIEN? [Does] Salterian Molting [occur] in Middle Cambrian Ogygopsis Walc. (Tril.) of British Columbia?: Hamburg, Geol. Staatsinst., Mitt., no. 29, p. 104-126, illus., Nov. 1960; text in German, summ. in English.

A specimen of *Ogygopsis klotzi* (Rominger) from the middle Cambrian of the Canadian Rockies in what seems to be 'Salterian molting' is described and its position shown to be incidental. The author

suggests to restrict the term 'Salterian molting' to cases in which, as the term implies, the position is actually caused by the special way of molting as described by R. Richter for certain middle Devonian phacopids, and is thus normal and prevailing.--Auth.

3-2587. Eaton, Theodore H., Jr. THE AQUATIC ORIGIN OF TETRAPODS: Kansas Acad. Sci., v. 63, no. 3, p. 115-120, 2 figs, Fall 1960, 14 refs.

A recently discovered aquatic amphibian, *Hesperoherpeton garnettense*, from the Pennsylvanian of Kansas shows characters of the limbs and vertebrae that are structurally ancestral to those of the Embolomeri. The Embolomeri are not far removed from the ancestral reptiles. *Hesperoherpeton* is characterized by vertebrae in which the intercentrum is U-shaped, the pleurocentra are paired half-rings, the limbs are transitional between crossopterygian fins and typical labyrinthodont limbs, and the cranium is little changed from that of the Rhipidistia.

Discussion of *Hesperoherpeton*, *Ichthyostegalia* and other forms suggests that the walking movements of early tetrapods, and the structure of their legs, feet and digits, originated as a purely aquatic adaptation long before there was any occasion for, or possibility of, sustained locomotion on land. The early amphibians were for many millions of years aquatic animals, even in their adult stages, and at least 3 orders, the Pleisioptera, Anthracosauria and Temnospondyli, as well as the subclass Lepospondyli, originated while this way of life prevailed.

The uneven, poorly known steps in evolution from water to land, indicate to the author that escape from drying pools played no essential part, or that the supposed aridity of the Late Devonian was not important in the evolution of the limb. The evolution of the limb appears to the author to be a natural adaptation for creeping about in water in restricted situations.--J. J. Stephens.

3-2588. Tihen, J. A. ON NEOSCAPHIOPUS AND OTHER PLIOCENE PELOBATID FROGS: Copeia, 1960, no. 2, p. 89-93, 8 figs., June 1960, 6 refs.

The records and characters of fossil Pelobatidae of the United States are summarized and several names synonymized, as in the following list: *Scaphiopus holbrookii*, Florida Pleistocene, and the same or a similar form from Florida Miocene; *Eopelobates*, Oligocene, South Dakota; *Spea alexanderi* Zweifel, lower Pliocene, Nevada; *S. diversus* Taylor, upper Pliocene, Kansas (*Neoscaphiopus noblei* Taylor); *S. plioatrachus* Taylor, middle Pliocene, Kansas (*Scaphiopus antiquus* Taylor); *S. studei* Taylor, middle Pliocene, Kansas; *S. bombifrons* Cope, Recent, and tentatively from Sangamon (Cragin quarry and Jinglebob faunas), Meade County, Kansas.--T. H. Eaton, Jr.

3-2589. Colbert, Edwin H. A NEW TRIASSIC PROCOLOPHONID FROM PENNSYLVANIA: Am. Mus. Nat. History, Am. Mus. Novitates, no. 2022, 19 p., 8 figs., Nov. 1960, 12 refs.

A natural mold of a fossil skeleton, from the upper Triassic Brunswick formation, near Bowmansville, Pennsylvania, is described as *Sphodrosaurus pennsylvanicus*, new genus and species, a cotylosaurian reptile belonging to the family Procolophonidae. *Sphodrosaurus* is characterized by various procolophonid features, but differs from other members of the family by reason of its unusually large skull



and its extraordinarily long, strong hind limbs, the feet of which are armed with long, sharp claws. This new fossil is one of a growing series of discoveries that show the proclophonids to have been a numerous and varied group of reptiles, widely distributed, in late Triassic times.--Auth.

3-2590. Stokes, William Lee, and A. F. Bruhn. DINOSAUR TRACKS FROM ZION NATIONAL PARK AND VICINITY, UTAH: *Utah Acad. Sci., Arts, & Letters, Proc.* v. 37, p. 75-76, 1959/1960, pub. 1960.

Two sets of large, bipedal, tridactyl dinosaur tracks from the Kayenta formation (Jurassic or Late Triassic), Utah, are described. As the Kayenta tracks are smaller than at least 90% of the tracks found in association with Cretaceous coal beds in central Utah, it is suggested that dinosaur tracks may be useful in dating the rocks that contain them.--M. Russell.

3-2591. Wood, Horace E., 2d. EIGHT HISTORIC FOSSIL MAMMAL SPECIMENS IN THE MUSEUM OF COMPARATIVE ZOOLOGY: *Harvard Univ., Mus. Comp. Zoology, Bull.*, v. 123, no. 3, p. 87-110, 8 figs., pl., 6 tables, Sept. 1960, 40 refs.

The fossil mammals of the Whitney collection from the California "auriferous gravels" are all of mid-Tertiary age, with the probable spread only from Orellan to Whitneyan (middle to upper Oligocene). The extreme possible spread would be from Chadronian to Arikarean.

*Subhyracodon kewi* is a reasonable structural ancestor for *Apelops*.

The rhinoceros tooth from Martha's Vineyard is assigned to *Diceratherium cf. armatum*, an Arikarean (lower Miocene) guide fossil.

The Harvard rhinoceros types of Scott and Osborn are redescribed and discussed. "*Hyracodon major*" is a synonym of *Hyracodon nebraskensis*. "*Hyracodon planiceps*" is placed in *Subhyracodon* as a *nomen dubium*, and the characters of *Metamynodon planifrons* are clarified.--Auth. summ.

3-2592. Olsen, Stanley J. ADDITIONAL REMAINS OF FLORIDA'S PLEISTOCENE VAMPIRE: *Jour. Mammalogy*, v. 41, no. 4, p. 458-462, fig. Nov. 1960, 3 refs.

Additional material of the vampire bat, *Desmodus magnus* Gut 1959, from Pleistocene (Illinoian) guano deposits found in the Reddick Cave, Marion County, Florida, indicates that *D. magnus* exhibits sufficient morphological differences to separate it as a distinct species from *D. stocki* or *D. rotundus*.

A summary of the vampire bat habits and the Reddick Cave fauna is given. The possibilities that the vampire contributed to the death and eventual destruction of the large warm-bodied animals of Pleistocene Florida are mentioned.--J. J. Stephens.

3-2593. Lawrence, Barbara. FOSSIL TADARIDA FROM NEW MEXICO: *Jour. Mammalogy*, v. 41, no. 3, p. 320-322, table, Aug. 1961, 3 refs.

A new species of free-tailed or guano bat, *Tadarida constantinei*, is described from decomposed bat guano. The material was collected at New Cave (also known as Slaughter Cave) in the Carlsbad Caverns National Park. The guano deposit in which the bones were found is dated older than 17,800 years before

the present. The fossil specimens are compared with *Tadarida brasiliensis mexicana*.--J. J. Stephens.

3-2594. Getz, Lowell L. MIDDLE PLEISTOCENE CARNIVORES FROM SOUTHWESTERN KANSAS: *Jour. Mammalogy*, v. 41, no. 3, p. 361-365, fig., Aug. 1961, 5 refs.

Additional collecting from the Crooked Creek formation (middle Pleistocene, Kansan-Yarmouth) yielded additional specimens and records of carnivores for the Cudahy and Borchers faunas. *Canis* sp., *Mustela cf. erminea*, and *Mustela cf. vison*, are reported from the Cudahy fauna. *Canis cf. latrans*, *Urocyon atwaterensis* sp. nov., *Mustela cf. frenata*, and *Spilogale cf. ambarvalis* are reported from the Borchers local fauna. *Urocyon atwaterensis* is described as a new species of the gray fox. The material was compared with *U. cinereoargenteus*.--J. J. Stephens.

3-2595. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 4, p. 134-138, Oct. 1960.

Seventy-five briefly annotated references are given, arranged alphabetically by author. References are world-wide and mainly from the period 1959-1960.--L. M. Dane.

3-2596. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 1, p. 27-32, Jan. 1961.

Ninety-five briefly annotated references are given, arranged alphabetically by author. References are world-wide and mainly from 1960.--L. M. Dane.

3-2597. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 2, p. 71-76, Apr. 1961.

Approximately 100 briefly annotated references are given, arranged alphabetically by author. References are world-wide and mainly from the period 1959-1960.--L. M. Dane.

3-2598. Toomey, Donald F. ANNOTATED BIBLIOGRAPHY OF PRECARBONIFEROUS FORAMINIFERA: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 2, p. 33-46, Apr. 1961.

This annotated bibliography includes 96 references pertaining to pre-Carboniferous Foraminifera, and may be considered reasonably complete through the year 1959. The bibliography has 3 distinct aims: 1) to summarize briefly the contents of each article, 2) to list all new genera and species described therein, and 3) to denote, by brackets, all taxonomic changes noted from later publications, thus making the bibliography a more useful working tool for specialists.--Auth.

3-2599. Uchio, Takayasu. HAPLOPHRAGMOIDES SANDIEGOENSIS, NOM. NOV.: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 2, p. 69, Apr. 1961.

*Haplophragmoides quadratus* Uchio, 1960, described from the San Diego, California, area, is

preoccupied by *Haplophragmoides quadratus* Earland, 1934, described from the Falklands sector of the Antarctic. The new name *Haplophragmoides sandiegoensis* is proposed for the San Diego form. --L. M. Dane.

3-2600. Toomey, Donald F. *ENDOTHYRA SCITULA*, NEW NAME FOR *E. SYMMETRICA* ZELLER, PRE-OCCUPIED: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 1, p. 26, Jan. 1961.

It has been discovered that *Endothyra symmetrica* Zeller, 1957 (Mississippian endothyroid Foraminifera from the Cordilleran geosyncline) is preoccupied by *E. symmetrica* Morozova, 1949 (representatives of the families Lituolidae and Textulariidae from the upper Carboniferous and Artinskian deposits of the Bashkirian pre-Ural). As *E. symmetrica* Zeller is used as a "stratigraphic marker," it is important that a correction be made; the author proposes to rename the form *Endothyra scitula*. --L. M. Dane.

3-2601. Smout, A. H., and F. E. Eames. THE DISTINCTION BETWEEN OPERCULINA AND OPERCULINELLA: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 4, p. 109-114, Oct. 1960, 44 refs.

Cole placed *Operculinella* and *Operculinoides* in the synonymy of *Operculina*. Nagappa takes a closely similar view. In our experience there is little practical difficulty in distinguishing 2 genera: *Operculina* which includes laxispiral, compressed, evolute forms and *Operculinella* which includes involute and partially involute species that increase in whorl height throughout the growth of the test but typically have more tightly coiled spires than *Operculina*. Cole includes more than one species in *Operculina ammonoides*; speciation is discussed and it is shown that gradation between fully evolute and partially involute species is not firmly proven. The existence of possible senior synonyms of *Operculinella* and *Operculinoides* will be discussed elsewhere. --Auth.

3-2602. Cole, W. Storrs. NAMES OF AND VARIATION IN CERTAIN INDO-PACIFIC CAMERINIDS-No. 2. A REPLY: *Bulls. Am. Paleontology*, v. 43, no. 195, p. 111-128, 3 pls., table, 1961, 15 refs.

This discourse presents additional evidence for the modification of the traditional classification of camerinids with undivided median chambers and is, in part, a reply to Smout and Eames [see above] who disagreed with the classification of certain Indo-Pacific species presented by Cole [GeoScience Abstracts 1-1171]. Whereas Smout and Eames recognize 7 species assigned to 2 genera, an attempt is made to demonstrate that there are only 3 species belonging to 1 genus. The causes of the variation between individuals in a given species are discussed and applied to series of specimens. --Auth.

3-2603. Said, Rushdi, and Samir F. Andrawis. LOWER CARBONIFEROUS MICROFOSSILS FROM THE SUBSURFACE ROCKS OF THE WESTERN DESERT OF EGYPT: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 1, p. 22-25, 10 figs., Jan. 1961, 15 refs.

Foraminifera separated from the subsurface rocks of Faghur well at the western boundary of northern Egypt suggest the presence of a lower Carboniferous

(Visean) occurrence in this locality. The discovery of this occurrence alters materially current conceptions of the paleogeography of the mobile shelf of Egypt. --Auth.

3-2604. Ross, Charles A. FUSULINIDS FROM THE HESS MEMBER OF THE LEONARD FORMATION, LEONARD SERIES (PERMIAN), GLASS MOUNTAINS, TEXAS: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 4, p. 117-133, 2 figs., 5 pls., 9 tables, Oct. 1960, 35 refs.

Five fusulinid zones are recognizable in the Hess member of the Leonard formation in the eastern Glass Mountains. These zones are useful for correlation and contain 2 species of *Schwagerina*, previously described, and 5 species of *Parafusulina* which are new. The assemblage of *Schwagerina crassitectoria* Dunbar and Skinner and *S. guembeli* Dunbar and Skinner forms the lowest zone, *Parafusulina allisonensis* n. sp. forms the second zone, *P. deltoides* n. sp. and *Parafusulina* sp. A form the third zone, *P. spissisepta* n. sp. forms the fourth zone which includes the upper Hess fossil bed of P. B. King, and the assemblage of *P. brooksensis* n. sp. and *P. vidriensis* n. sp. forms the fifth and highest zone of the Hess member. The distribution of these species of fusulinids in these zones is closely related to the types of limestones.

A possible species of *Eoverbeekina* found near the base of the Hess member in the double ledge may be one of the earliest occurrences of a member of an Asian fusulinid fauna to be reported from the standard Permian section. --Auth.

3-2605. Wall, J. H. JURASSIC MICROFAUNAS FROM SASKATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 53, 229 p., 4 figs., 2 charts, 28 pls., 1961, 98 refs.

Ninety-five species and varieties belonging to 39 genera of Foraminifera, and 33 species and varieties representing 15 genera of Ostracoda are figured and described from the Middle and Upper Jurassic sediments of Saskatchewan. Fourteen species of Foraminifera and 3 ostracode species are proposed as new.

The Jurassic stratigraphy of the western interior of the United States and Canada is summarized from published sources to provide background for viewing the Saskatchewan Jurassic sequence in its regional relationship. The Jurassic strata of Saskatchewan are discussed in some detail with the objective of coordinating the systems of nomenclature employed by different workers. The microfaunas of this sequence are listed, and attention is directed toward species restricted to various stratigraphic levels. The Shaunavon formation of Saskatchewan is believed to be correlative with the Piper and Sawtooth formations of Montana which are Bathonian in age. The lower member of the Vanguard formation is equivalent to the Rierdon formation of Montana and the Stockade Beaver shale member of the Sundance formation in the Black Hills area which are Callovian in age. The middle and upper members of the Vanguard formation are collectively equated with the Swift formation of Montana and its correlative in the Black Hills, the Redwater shale member of the Sundance, which are Oxfordian in age.

Marine ostracodes seem to be the best group of microfossils for determination of biostratigraphic correlation in the Upper Jurassic of the western interior region. Foraminifera from the Saskatchewan Jurassic appear rather long-ranging with



only a relatively small number of species restricted to any one stage. Charophytes and nonmarine ostracodes are shown to be indicators of time planes when a sudden widespread change in environment rendered conditions favorable for their success.

The general aspect of the microfossils implies shallow-water deposition for the Shaunavon and Vanguard formations. The assemblages further seem to indicate that salinity varied from normal marine to weakly brackish (nearly fresh) levels but probably was nearly normal much of the time.--Auth.

3-2606. Graham, Joseph J., and Dana K. Clark. LACOSTEINA PAYNEI, A NEW SPECIES FROM THE UPPER CRETACEOUS OF CALIFORNIA: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 4, p. 115-116, fig., pl., Oct. 1960, 9 refs.

The new species, *Lacosteina paynei*, is described. It is found in the uppermost concretionary sandstone of the Uhalde formation and the Dosados member of the Moreno formation, and is of Maastri-chtian age; it is the first reported occurrence of the genus in California.--Auth.

3-2607. Hofker, Jan. ON THE "GENUS" CATAPSYDRAX, AND THE GLOBIGERINA QUADRILOBATA GENS: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 2, p. 64-68, 11 figs., Apr. 1961, 12 refs.

The "genus" *Catapsydrax* is a polyphyletic one, inasmuch as globigerines of the "clustered" type all seem to go through various developmental stages during geologic time. These stages begin with *Globigerina*, then change into "*Globigerinoides*," and each species ends with tests which, when adult, develop "*Catapsydrax*" chambers. This was shown for *Globigerina daubjergensis*, *G. venezuelana* (where the *Globigerinoides*-stage is absent), and also for *G. quadrilobata-triloba-sacculifera*. Typical "*Catapsydrax*" chambers also are formed frequently in *G. (Globigerinoides) conglobata*. Polyphyletic genera however, do not form biologic units and for this reason should be withdrawn as soon as possible. *Catapsydrax* chambers seem to be developed at the end of each generic appearance as a means of forming cysts for sporulation, somewhat in the same way as occurs in benthonic Foraminifera which form mud cysts. *Catapsydrax* chambers also are found in *G. minuta*. Thus, specimens with *Catapsydrax* chambers are found during the entire Tertiary and are very common in the Recent.--Auth.

3-2608. Loeblich, Alfred R., Jr., and Helen Tappan. A VINDICATION OF THE ORBULINA TIME SURFACE IN CALIFORNIA: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 1, p. 1-4, Jan. 1961, 32 refs.

During the last 15 to 20 years, considerable evidence has been cited for a world-wide "time surface" based upon the first appearance of the planktonic foraminiferal genus *Orbulina*. Although most specialists on *Orbulina* are convinced of the validity of this time surface, a few records of pre-Miocene *Orbulina* continue to appear. Several references to pre-Miocene *Orbulina* are shown to be based on misidentifications and represent various other foraminifera, holothurian sclerites, *Oligostegina*, *Pithonella*, inorganic bodies, etc.

The authors conclude that *Orbulina* does not appear in California in any Eocene strata observed,

and it is regarded as highly unlikely that any true examples of the genus will be found in pre-Miocene strata either in California or elsewhere.--L. M. Dane.

3-2609. Cooper, William Clinton. INTERTIDAL FORAMINIFERA OF THE CALIFORNIA AND OREGON COAST: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 2, p. 47-63, 4 figs., 5 tables, Apr. 1961, 28 refs.

A total of 51 beach and tidepool samples was taken along the coast of California and Oregon, a distance of approximately 1,105 statute mi. Over 120 species representing 57 genera were collected. All 3 test types (arenaceous, porcellaneous, and hyaline) are present. By the use of percentage of population methods it was possible to recognize characteristic living provincial and cosmopolitan faunas within this area. Living present-day benthonic species predominated in the area of study, with fossil and planktonic species occurring in only insignificant numbers. The area studied is a coast of upwelling, but no deep-water Foraminifera were collected. There is an increase from N. to S. in the number of genera and number of species with a resultant increase in the variety of the faunas. There is no corresponding increase in the number of individuals or total population.--Auth.

3-2610. Todd, Ruth, and Doris Low. NEAR-SHORE FORAMINIFERA OF MARTHA'S VINEYARD ISLAND, MASSACHUSETTS: Cushman Found. Foraminiferal Research, Contr., v. 12, pt. 1, p. 5-21, 2 figs., 2 pls., table, Jan. 1961, 13 refs.

Foraminifera were studied from 102 samples collected from beaches and shallow water around the island of Martha's Vineyard. Forty-two species, none new, were identified from several ecologic groupings, and most of the specimens were living where collected. One species, *Streblus beccarii* (Linné), is represented by its typical form only along the ocean beaches and by its smaller and delicate subspecies *tepida* elsewhere around the island. Most abundant and nearly ubiquitous around the island are *Quinqueloculina lata* Terquem, *Rosalina columbiensis* (Cushman), and *Streblus beccarii tepida* (Cushman). Abundant but environmentally restricted are *Elphidium margaritaceum* Cushman, *E. galvestonense* Kornfeld, *Protelphidium tisburyense* (Butcher), *Trochammina inflata* (Montagu), *T. macrescens* Brady, *Quinqueloculina seminulum* (Linné), and *Q. subrotunda* (Montagu).

Major faunal distinctions exist between ocean-facing beaches, sound-facing beaches, protected bays, brackish ponds, stream entrances, and surfaces of submerged bogs. Foraminifera appear to thrive best in association with seaweed and algae and in organic-rich sediments. Clean sand beaches are virtually barren.--Auth.

3-2611. Axelrod, Daniel I. HOW OLD ARE THE ANGIOSPERMS?: Am. Jour. Sci., v. 259, no. 6, p. 447-459, June 1961, 22 refs.

Available evidence has earlier led to the inference that ancient angiosperms originated in moist tropical upland regions during Permo-Triassic time.

Recent arguments, which purport to show that there was a much briefer interval between the time of origin and appearance of angiosperms in the record, and that they evolved in lowland areas, are not consistent with evidence from morphology, evolution, paleoecology, or paleoclimate.--Auth.

3-2612. Chandler, Marjorie E. J., and Daniel I. Axelrod. AN EARLY CRETACEOUS (HAUTERIVIAN) ANGIOSPERM FRUIT FROM CALIFORNIA: *Am. Jour. Sci.*, v. 259, no. 6, p. 441-446, 2 pls., June 1961, 6 refs.

A well-preserved fruit that may represent an extinct angiosperm of the Family Icacinaceae, or a precursor of the family, has been found in the Ono formation of northern California associated with marine invertebrates of Hauterivian age. This section has earlier yielded a small transported flora consisting of an angiosperm of doubtful affinity, together with typically Neocomian conifers, ferns, and cycadophytes that appear to have characterized the vegetation of the adjacent shore area.--Auth.

3-2613. Detling, Leroy E. THE CHAPARRAL FORMATION OF SOUTHEASTERN OREGON, WITH CONSIDERATION OF ITS POSTGLACIAL HISTORY: *Ecology*, v. 42, no. 2, p. 348-357, fig., table, Apr. 1961, 8 refs.

A chaparral formation floristically related to that of central and northern California grows in the Rogue River and Umpqua Valley regions, where mean annual precipitation ranges between 312 and 742 mm., of which summer precipitation is from 17% to 28%, and where temperatures range from mean winter minima of  $-5.8^{\circ}$  to  $0.7^{\circ}$  C. to mean summer maxima of  $29.9^{\circ}$  to  $33.7^{\circ}$  C. Paleobotanical evidence indicates an essentially Californian range for chaparral during the Pleistocene, but relicts suggest that the formation has once extended northward almost to Puget Sound, requiring a former annual rainfall 230 mm. below today, and former winter minima and summer maxima higher by  $1.0^{\circ}$  and  $5.0^{\circ}$  C, respectively. Thus this temporary extension of the chaparral formation marks a post-glacial xenothermic climatic phase.--J. W. Valentine.

3-2614. Brown, Clair A. PALYNOLOGICAL TECHNIQUES: 188 p., The Author, 1180 Stanford Ave., Baton Rouge 8, Louisiana, 1960, approx. 200 refs.

This publication is an outgrowth of investigation of the pollen content of a wide variety of materials such as water, peats, gyttja, sand, shales, rock salt, lignites, coals, and asphalts from surface samples to well cores 10,000 ft. below the surface.

One of the necessary phases of palynology is the liberation of pollen from a variety of sediments. The beginner, in reading much of the literature, finds many indefinite statements on procedures. Surveys and summaries on techniques have been written, but there is no detailed compilation of all the techniques in English. The writer has selected procedures published by other investigators if they show detailed steps or variants which can be useful to others for particular types of materials. Most of the techniques mentioned have been tested, and many have given good results. The literature undoubtedly contains other worthwhile methods not covered here.

The text deals with the following subjects: preparation of reference slides; peats, soils, and clays; coals; rocks and shales; oils, acids, and bitumens; ice and honey; stains; centrifugation; mounting media; action of chemicals; single grain technique; processing procedure. The appendix contains a list of equipment and supplies and an outline for description of pollen and spores.--A. C. Sangree.

3-2615. Samoilovich, S. R. POLLEN AND SPORES FROM THE PERMIAN DEPOSITS OF THE CHERDYN' AND AKTYUBINSK AREAS, CIS-URALS. Translation by M. K. Elias: *Oklahoma Geol. Survey, Circ. 56*, 103 p., 17 pls., 4 tables, 1961, 39 refs.

The present work was initiated with a view to describing the characteristics of spores and pollen which occur in the Permian terrestrial deposits of the Cis-Urals, so that they can be used for stratigraphic subdivisions and correlations of the sediments. The materials investigated include personal samples from the cores of some bore holes in the vicinity of Cherdyn city, as well as samples from the collections of V. P. Pnevva from the Aktyubinsk area, and of E. M. Lyutkevich from the region of Solikamsk city and Udmurtsk, A. S. S. R.

On the evidence obtained by the author, the following brief conclusions can be made: 1) Spore-pollen complexes of the studied Permian deposits in the Cherdyn and Aktyubinsk areas are similar. 2) The spore-pollen complex of the Artinskian rocks has several characteristics which distinguish it from spore-pollen complexes of the stratigraphically higher Permian deposits. 3) The spore-pollen complexes of the salt-bearing Kungurian and post-salt-bearing Solikamsk suite of the Cherdyn area, in spite of similar contents, have several differences which permit us to distinguish one from the other when engaged in serial investigations.

4) Taking into account the differences between the spore-pollen complexes of the Solikamsk suite and the Kungurian, the principal of which is the sharp reduction of the proportion of cordaitalean pollen and increase of the proportion of coniferous pollen (which is characteristic of the Upper Permian) in the first, and also taking into account the similarity of the basic characteristics of the spore-pollen complexes in the Solikamsk suite and the Kazanian stage, it is possible to refer the suite to the latter stage. This thesis appears, to a certain degree, arbitrary, because a larger amount of comparative data on the spores and pollen from the rocks of undoubted Kazanian age is needed for its verification.

5) Comparison of spore-pollen complexes in the stages of the Cherdyn area with the contemporaneous spectra of other areas of the western Cis-Urals (Nytyva and Solikamsk areas), as well as the complex from the northern Keltma river basin, shows their almost complete identity. This suggests the possibility of establishing, through the study of pollen and spores, correlation of the Permian deposits of some territories considerably remote from each other (western Cis-Urals and southern approaches to Timan).

6) Comparison of the morphological characteristics of the spores and pollen from the Permian with the morphology of the pollen and spores of the extant plants results in many cases in the establishment of some common features (it is discovered that some fossil pollen and spores resemble the pollen and spores of the extant plants of the families Pinaceae, Podocarpaceae, Welwitschiaceae, Osmundaceae, Marattiaceae, and Selaginellaceae).

7) Comparison of the Permian pollen with the pollen of some Paleozoic plants, which have been described from their pollen sacks, indicates similarity of some genera to the pollen of Cordaites and primitive conifers (*Lebachia*, *Walchia*, *Ernestiodendron*). 8) Judging by the pollen and spore contents, there was a vegetation in the Permian period on the territory of the Cherdyn and Aktyubinsk areas represented chiefly by conifers and cordaitaleans, with a slight addition of Ginkgoales and Cycadophyta, and also fern, *Calamites*, and lycopods.--From auth., p. 8, 28-29



3-2616. McCammon, Helen. FAUNA OF THE MANITOBA GROUP IN MANITOBA: Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 59-6, 109 p., 2 figs., 13 pls., 4 tables, 1960, 79 refs.

A faunal study of the Manitoba group in Manitoba indicates that the lower Dawson Bay formation is Middle Devonian and the upper Souris River formation is Upper Devonian. Faunal zonation of the 2 formations is proposed; the Dawson Bay and Souris River are each subdivided into 4 zones. Fauna from the Dawson Bay is shown to be unrelated to that in the underlying Winnipegosis and Elm Point formations. The Dawson Bay formation correlates closely with the Cedar Valley formation of Iowa, Illinois, and Minnesota, and possibly with the Milwaukee dolomite of Wisconsin and the Williams Island formation of the James Bay lowland. The Souris River formation correlates closely with the Waterways formation of Alberta.

New species and varieties described from the Dawson Bay include: 2 stromatoporoids, *Anostylostroma bailliei* and *Ferestromatopora convergens*; 6 corals, *Amplexiphyllum salinensis*, *Buschophyllum minutum*, *Tabulophyllum gallina*, *Favosites pachymuralis*, *Thamnopora dumosa* var. *tabulata*, *Coenites hadrus*; 1 bryozoan *Cyphotrypa whiteavesi*; 4 brachiopods, *Atrypa manitobensis*, *Atrypa snakensis*, *Spinatrypa mascula* var. *manitobensis*, *Cyrtina paucicostata*; and 1 trilobite *Proetus manitobensis*.--Auth.

3-2617. Brindle, John E. THE FAUNAS OF THE LOWER PALAEOZOIC CARBONATE ROCKS IN THE SUBSURFACE OF SASKATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 52, 45 p., 3 figs., 8 pls., table, 1961, 17 refs.

The fossils studied in this report (over 80 species, principally coelenterates and brachiopods) were obtained from all well cores taken in the lower Paleozoic carbonate rocks of Saskatchewan (Ordovician Bighorn and Silurian Interlake groups) available to the writer to the end of Sept., 1959. The faunal assemblage is presented from, and an age ascribed to each of the stratigraphic units in this succession. The Bighorn group appears to be of Upper Ordovician age for most of its thickness. The Ordovician-Silurian boundary may occur within the Stonewall formation, the uppermost unit of the Bighorn group. The Interlake group appears to include both Lower and Middle Silurian strata. There is no evidence of angular unconformities or erosional gaps within or between the Ordovician and Silurian strata. Correlations are proposed between the Ordovician and Silurian carbonate rocks of Saskatchewan and those of eastern Montana, northern Wyoming and the outcrop areas of Manitoba. The correlations of Porter and Fuller and Ross are reinforced. The fossils are illustrated by photographs wherever possible.--Auth.

3-2618. McKenna, Malcolm C. A CONTINENTAL PALEOCENE VERTEBRATE FAUNA FROM CALI-

FORNIA: Am. Mus. Nat. History, Am. Mus. Novitates, no. 2024, 20 p., 4 figs., Nov. 1960, 23 refs.

The oldest known continental Cenozoic fossil vertebrates from California were collected in the El Paso mountains near the town of Inyo Kern. Two small faunules, designated the Laudate local fauna, were obtained from the upper member of the Foler formation. The faunules, separated by approximately 3,400 ft. of rapidly accumulated continental sediments, now total 5 identifiable mammal teeth, a ?Chelonian phalanx, an isolated crocodilian tooth and an osteichthian tail. The lower member of the Goler formation has not yielded fossils.

In addition to the reptiles, the upper faunule is represented by an anisonchine condylarth and a eucosmodontine multituberculate. Anisonchine condylarths have been found in Puercan (approx. early Paleocene) and Torrejonian (approx. middle Paleocene) sediments only. Eucosmodontine multituberculates belong to a group presently known only from Tiffonian (approx. late Paleocene) to Wasatchian (approx. early Eocene) sediments, but their occurrence in middle and perhaps early Paleocene sediments is to be expected. The single condylarth molar and the fish tail from the lower faunule provide little chronologic information.--H. A. Semken, Jr.

3-2619. Sass, Daniel B. SOME ASPECTS OF THE PALEONTOLOGY, STRATIGRAPHY, AND SEDIMENTATION OF THE CORRY SANDSTONE OF NORTHWESTERN PENNSYLVANIA: Bulls. Am. Paleontology, v. 41, no. 192, p. 251-381, 4 figs. (1 in pocket), 8 pls., 8 tables, 1960, 186 refs.

A thorough study of the fauna of the Corry sandstone of northwestern Pennsylvania is herein initiated. Species of 4 genera, 2 of the Porifera and 2 of the Brachiopoda, are described. Some hitherto unrecognized morphological characteristics of the Dictyospongiidae are emphasized.

Four species of the brachiopod genus *Paraphorhynchus* Weller (1905) are described, one of which, *P. casteri* is new. A new criterion of the genus is proposed in the presence of a "posterior adductor process" in the pedicle valve. Characteristics of the genus *Syringothyris* Winchell (1863), s.s., are evaluated; 2 Corry species are redescribed and compared with similar forms in the underlying Knapp formation. The synonymous relationship between *S. randalli* and *S. angulata* postulated by Caster is rejected.

An attempt is made to reconstruct the former continuity of the Corry sandstone throughout its area of surface outcrop in northwestern Pennsylvania. The formation is divided into 3 members: 1) a lower sandstone member; 2) a middle siltstone; and 3) an upper sandstone member.

The Lower Mississippian (Kinderhookian) age of the Corry is reaffirmed. A correlation of the lower Corry member with the upper portion of the Bedford shale of Ohio is suggested.--Auth.

## 6. GEOPHYSICS

See also: Structural Geology 3-2538, 3-2540; Engineering Geology 3-2807.

3-2620. Howell, B. F., Jr., and P. H. Licastro. DIELECTRIC BEHAVIOR OF ROCKS AND MINERALS: Am. Mineralogist, v. 46, no. 3/4, p. 269-288, 11 figs., table, March-Apr. 1961, 34 refs.

A reconnaissance study of the dielectric constants of 23 common mineral and 71 rock samples was made at 13 frequencies in the range 50 c.p.s. to 30 megacycles. Dispersion was observed for all rock samples tested and for a few minerals at the lower end of the frequency spectrum. Moisture in a rock can increase the dielectric constant by an amount greater

than is predicted by simple mixing rules. Water appears to be the principal constituent of the rock controlling the dispersion. The observed dispersion was similar in form to Maxwell-Wagner type polarization, but was quantitatively much greater. Some form of electrode or membrane polarization appears to be the most likely explanation. The dispersion is probably a result of the same mineral properties on which induced-polarization methods of geophysical prospecting are based.--Auth.

3-2621. Chakrabarty, S. K., and A. N. Tandon. CALIBRATION OF ELECTROMAGNETIC SEISMOGRAPHS SATISFYING GALITZIN CONDITIONS: *Seismol. Soc. America, Bull.*, v. 51, no. 1, p. 111-125, 4 figs., table, Jan. 1961, 5 refs.

A large number of electromagnetic seismographs are now in operation at the different stations of the world network of seismological observatories, and valuable data have been collected through them. Various attempts have earlier been made for the precise estimation of the instrumental constants as well as the magnification curves, but such estimations were not precise either due to approximations introduced in the analysis or due to difficulties of precision measurements during the experiments suggested for the determination of some of the instrumental constants.

In the present paper theoretical results have been given for the response of the seismographs to different tests required in the calibration of the electromagnetic seismographs, and also to sinusoidal ground motion. The "reaction of the seismometer and galvanometer" has been retained. Final results have also been given for the special types of seismographs in which the seismometer period and galvanometer period are equal and the galvanometer is critically damped. The variation of the magnification curve as well as that of the response to different tests, with changes in the reaction and seismometer damping, have been obtained. Methods have been indicated by which the instrumental constants can be determined and the seismographs can be adjusted to any prescribed condition. The results of calibration of a Sprengnether seismograph in operation at the Central Seismological Observatory, Shillong, India, have been given. The methods suggested can also be used in the precise estimation of the instrumental constants and the magnification of seismographs of the Galitzin type even in their past operating condition, if the routine test data, particularly the response to tapping test and sudden impulse test are available.--Auth.

3-2622. Byrne, C. J. INSTRUMENT NOISE IN SEISMOMETERS: *Seismol. Soc. America, Bull.*, v. 51, no. 1, p. 69-84, 8 figs., Jan. 1961, 12 refs.

Methods are developed to analyze the effects of thermal noise and seismic noise in masking small earth vibrations. The procedure is applied to a simple seismometer, seismometers with electronic and galvanometer amplifiers, and a seismometer with a shunt capacity.

A numerical example is worked out for the Benioff one-second instrument. In the 0.1 second to 10 second band, thermal noise is not limiting.--Auth.

3-2623. Adams, W. Mansfield, and D. C. Allen. READING SEISMOGRAMS WITH DIGITAL COMPUTERS: *Seismol. Soc. America, Bull.*, v. 51, no. 1, p.

61-67, 8 figs., Jan. 1961, 4 refs.

A device that permits direct input of seismic traces into electronic digital computers is described. Examples of its use and its several merits are presented. The devices make feasible numerical analysis of data recorded in analog form on photographic film or paper.--Auth.

3-2624. Aki, Keiiti, and John M. Nordquist. AUTOMATIC COMPUTATION OF IMPULSE RESPONSE SEISMOGRAMS OF RAYLEIGH WAVES FOR MIXED PATHS: *Seismol. Soc. America, Bull.*, v. 51, no. 1, p. 29-34, 3 figs., Jan. 1961, 4 refs.

A program has been devised to compute theoretical seismograms of Rayleigh waves for a given epicenter and a given station entirely automatically on an electronic computer.

The earth's surface is divided into 3 regions; continents, Pacific Ocean, and oceans other than the Pacific. Allowance can be made for differences in structure in these regions. This simple division seems satisfactory at present for Rayleigh waves of periods longer than 35 sec.--Auth.

3-2625. SEISMOLOGICAL NOTES: *Seismol. Soc. America, Bull.*, v. 51, no. 1, p. 127-131, Jan. 1961.

Lists 84 areas of earth shocks for the period July 13, 1960 - Oct. 20, 1960. Also included are station notes briefly describing newly installed seismological observatories in Honiara, Guadalcanal, and the Wichita Mountains, Oklahoma. The latter site will evaluate technical capabilities of such a station in detecting and identifying underground explosions and natural earth motion.--E. Aleshin.

3-2626. Berg, Joseph W., Jr. EARTHQUAKES NEAR NEPHI, UTAH, ON NOVEMBER 28, 1958, AND DECEMBER 1, 1958: *Utah Acad. Sci., Arts, & Letters, Proc.* v. 37, p. 77-79, 2 figs., table, 1959/1960, pub. 1960, 3 refs.

Four earthquakes of intensities III-V, Modified Mercalli, occurred on Nov. 28-Dec. 1, 1958. They were associated with a known fault zone about 1 mi. N. of Nephi, Utah. Isoseismal maps show the intensity pattern for each.--M. Russell.

3-2627. Oliver, Jack E. ON THE LONG PERIOD CHARACTER OF SHEAR WAVES: *Seismol. Soc. America, Bull.*, v. 51, no. 1, p. 1-12, 9 figs., Jan. 1961, 11 refs.

S and multiple S phases at moderate to large epicentral distances are frequently followed by normally-dispersed, long-period, wave trains for which surface particle motion is elliptical and progressive and in the plane of propagation of the SV wave. The character of such phases can be explained as the result of coupling between the incident shear waves and dispersive PL waves in the near-surface wave guide. A detailed study of shocks in Mexico and in Montana recorded at Resolute [Northwest Territories, Canada], and less detailed studies of other data support this hypothesis.--Auth.

3-2628. Hatherton, T. A NOTE ON THE AMPLITUDE-PERIOD RELATIONSHIP OF EARTH NOISE IN THE ONE TO EIGHT SECOND RANGE: *Seismol. Soc. America, Bull.*, v. 51, no. 1, p. 13-16, 2 figs., Jan. 1961, 8 refs.



Maximum values of surface particle displacement due to microseisms recorded at an Antarctic seismological station (Scott Base) are compared with the displacements obtained by Romney at Harvard and Pinewoods. The relation of the displacement to the fourth power of the period obtained by Romney is confirmed by the Antarctic data.--Auth.

3-2629. Brekhovskikh, Leonid M. WAVES IN LAYERED MEDIA. Translated from the Russian by David Lieberman. Translation edited by Robert T. Beyrer: 561 p., 189 figs., 13 tables, New York, Academic Press, 1960, 208 refs.

A systematic exposition of the theory of the propagation of elastic and electromagnetic waves in layered media. The book is not restricted to Soviet work, but it does present a complete picture of Soviet research in this field. The following subjects are dealt with in turn: plane waves in layers; some applications of the theory of plane wave propagation in layered media; plane waves in layered-inhomogeneous media; reflection and refraction of spherical waves; wave propagation in layers; the field of a concentrated source in a layered-inhomogeneous medium.--A. C. Sangree.

3-2630. Deresiewicz, Herbert. THE EFFECT OF BOUNDARIES ON WAVE PROPAGATION IN A LIQUID-FILLED POROUS SOLID: II. LOVE WAVES IN A POROUS LAYER: Seismol. Soc. America, Bull., v. 51, no. 1, p. 51-59, Jan. 1961, 5 refs.

The transcendental equation is derived relating frequency and phase velocity of propagation of Love waves in a porous layer containing a viscous liquid. This equation, being complex, can be satisfied only if the wave number of the motion is complex, indicating that the disturbance is dissipative.

The general expression being intractable analytically, an approximate scheme is employed to determine the phase velocity and measure of dissipation valid for porous materials in which the mass (per unit volume of aggregate) of the interstitial liquid is smaller than that of the solid.--Auth.

Pt. I was listed as GeoScience Abstracts 3-518.

3-2631. Knopoff, Leon, and Freeman Gilbert. DIFFRACTION OF ELASTIC WAVES BY THE CORE OF THE EARTH: Seismol. Soc. America, Bull., v. 51, no. 1, p. 35-49, 15 figs., table, Jan. 1961, 9 refs.

The problem of the diffraction of a seismic pulse by the core of the earth is investigated theoretically. The result is compared to that of diffraction by a half-plane. The differences are striking. Laboratory model experiments have been performed to verify the theoretical approximations in their regions of validity, and to complement the theory elsewhere. The curves, thus obtained, of the theoretical amplitude distribution in the shadow of the earth's core agree very well with the observations of Gutenberg. It is therefore concluded that diffraction is a completely adequate explanation for the amplitude distribution in the shadow zone.--Auth.

3-2632. Sarmiento-Soto, Roberto. GEOLOGICAL FACTORS INFLUENCING POROSITY ESTIMATES FROM VELOCITY LOGS: Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 5, p. 633-644, 17 figs., 6 tables, May 1961, 10 refs.

The close relation between acoustic velocity and porosity makes it possible to use velocity logs to determine porosity. However, velocity or its reciprocal - travel time - also depends on other geological factors which, if known, permit more accurate log interpretation.

The travel time-porosity relations for sandstones depends on geological factors such as the rock's age, composition, depth, tectonic history (compaction), shaliness, and type of fluid in its pores. Of these parameters, depth and shaliness are the most important. Travel time-porosity relations were computed by statistical methods, which took into consideration the variables mentioned. The resulting equations give more accurate porosity estimates than the time-average equation, which is in widespread use.

Velocities of carbonate rocks are much less affected by depth than are those of the sandstones. On the other hand, mineralogical composition is of importance; pure dolomites show higher velocities, i. e., shorter travel times, than limestones of equal porosity. However, if the dolomites are impure, the porosity-travel time relation does not differ appreciably from that for limestone. The velocity log tends to give pessimistic porosity estimates in the case of vuggy carbonates, especially if the vugs are large. Statistical travel time-porosity relations were computed for Paleozoic limestones and dolomites. These equations are closer to the time-averaged model than the sandstone relations are.--Auth.

3-2633. Press, Frank. THE EARTH'S CRUST AND UPPER MANTLE: Science, v. 133, no. 3463, p. 1455-1463, 13 figs., May 12, 1961, approx. 20 refs.

Refinements of seismic methods are being used to study the density and layering of the earth. The reality of the Conrad discontinuity, crustal layering under the continents, mechanism of isostatic compensation of topographic highs, the merger between "continental" and "oceanic" crustal layering sequence, and the significance and distribution of the low seismic velocity layer in the upper mantle are being investigated. Improvements in technique, such as correlation refraction shooting, the detailed analysis of surface waves, and gravity observations, are discussed. A combination of these seismic methods and direct drilling may help explain the connection between the seismic and physico-chemical layering in the crust and mantle. The International Geophysics Committee has established an "Upper Mantle Project" to help coordinate these researches.--F. P. Glasser.

3-2634. Hoffman, John P. and others. DISCONTINUITIES IN THE EARTH'S UPPER MANTLE AS INDICATED BY REFLECTED SEISMIC ENERGY: Seismol. Soc. America, Bull., v. 51, no. 1, p. 17-27, 4 figs., 3 tables, Jan. 1961, 23 refs.

Thirty-three seismograms from 9 large quarry blasts ranging in size from 50,000 to 2,138,000 lb. of explosives were analyzed for possible reflections from inhomogeneities in the earth's upper mantle. Of the 33 seismograms, 4 were obtained at temporary seismograph stations positioned between 90 and 243 km. from the explosions and an array of 3 to 4 seismometers was used at each of the stations. The remaining 29 seismograms were obtained from 10 permanent seismograph stations located between 76 and 1,009 km. from the explosions. Seven of these latter seismograms were obtained from the

seismograph station at Salt Lake City, Utah, and 6 were obtained from the seismograph station at Eureka, Nevada. Each arrival on these 13 seismograms was noted and then correlated to determine which arrivals were common to all seismograms having nearly constant epicentral distances.

Of the 9 quarry blasts recorded, 7 were detonated at Promontory, Utah, and 2 were detonated at Lakeside, Utah, which lies about 33 km. W. of Promontory. This multiplicity of blasts resulted in 2 groups of seismograms for both the Salt Lake City and Eureka stations with one group at each station having a different epicentral distance from the other group at the same station. A comparison was made between the seismograms of each station based on the apparent velocity of the arrivals across this difference in epicentral distance. Seismic arrivals having apparent velocities that would be representative of deep reflections were selected from the aforementioned arrivals common to most records.

The remaining 16 seismograms, which were from 8 permanent seismograph stations located at epicentral distances in excess of 500 km., were used to check the results from the analysis of the Salt Lake City, Eureka, and temporary stations.

Times of possible reflected events are presented which could result from energy reflected at discontinuities in the upper mantle at depths of about 190, 520, and 910 km. The depths were computed using average velocities based on velocity-depth curves given by Jeffreys and Gutenberg for the deeper portions of the upper mantle and assuming that linear ray paths pertained.--Auth.

**3-2635. MacDonald, Gordon J. SEISMIC ACTIVITY OF THE MOON: Lunar & Planetary Explor. Colloquium, Proc., v. 2, no. 2, p. 45-47, illus., 1960.**

Various models of the moon were constructed in which thermal energy is converted into mechanical energy to determine the rate at which this energy is released. The purpose was to decide whether natural seismic activity might be expected on the moon, based on what is known of the composition of the moon and making certain assumptions as to age and make-up. Assuming a moon of chondritic composition and initial temperature of  $0^{\circ}\text{C}$ ., strain energy over the last billion years and at present would be released at a rate of  $1 \times 10^{25}$  ergs per year. Depending on whether the moon began warm or cold, one would expect, respectively, from one-fifth to considerably more seismic activity than is present on earth.--M. Russell.

**3-2636. Shmonin, L.I., and others. INVESTIGATION OF NEUTRON FLUX IN THE EARTH'S CRUST: Geokhimiya, in translation, 1959, no. 2, p. 127-132, 2 tables, pub. 1960, 7 refs.**

The neutron flux near the earth's surface consists of 2 components, 1) the cosmic ray secondaries, and 2) the neutrons produced by nuclear processes within the earth's crust capable of inducing nuclear transmutations in terrestrial matter. The present paper is a report of the field investigations of neutron flux in the earth's crust made in 1957 [in U.S.S.R.]. In a number of rocks and in some hydrothermal deposits, the flux of fast and slow neutrons is extremely small and is less than the error of measurement. The carbonate formations of Kvaisha have an observable neutron flux ( $I=0.2-0.25 \text{ n/cm}^2\text{-hour}$ ). The neutron flux in the weakly active areas of the earth's crust is, on the average, very weak,

and the values of  $I_S$  and  $I_F$  do not exceed fractions of a neutron per  $\text{cm}^2\text{-hour}$ . Only in some ore bodies the neutron flux increases to  $I_S=2.5$  and  $I_F=1.8 \text{ n/cm}^2\text{-hour}$ . In underground workings with highly radioactive rocks, the neutron flux up to  $I_F=32.4$  and  $I_S=28.2$  has been observed. The flux increases on the average by  $\Delta I_F=1.8$  and  $\Delta I_S=1.1$  (in neutrons per  $\text{cm}^2\text{-hour}$ ) as gamma-activity increases by 100  $\mu\text{r}$  per hour.--M. Russell.

**3-2637. Decius, L. Courtney. GEOLOGICAL ENVIRONMENT OF HYPERTHERMAL AREAS IN CONTINENTAL UNITED STATES AND SUGGESTED METHODS OF PROSPECTING THEM FOR GEOTHERMAL POWER: United Nations, Conference on New Sources of Energy, Solar Energy, Wind Power and Geothermal Energy, E/Conf. 35/G/48, Agenda Item II. A.1, 20 p., 4 illus., 2 maps, [New York], Apr. 1961.**

Geothermal heat to be of economic value, must be contained in gases or fluids as mobile carriers. If contained in gases, such gases must be under pressures sufficient to produce from wells and transmit to engines with adequate remaining pressure to drive the engines. If contained in water the temperature must be sufficiently high to flash off steam or permit heat transfer to some other media more adaptable for driving engines. For convenience, springs and thermal areas meeting the above requirements will be referred to as hyperthermal.

Occurrence of hyperthermal springs and areas in the United States is limited to that region lying W. of the easterly front of the Rocky Mountain System. It is significant that late Tertiary and Quaternary volcanism is likewise limited to the same area and that nearly all hyperthermal activity is closely associated with such volcanic areas.

Excluding the spectacular occurrences in Yellowstone National Park there are some 700 known thermal springs in western United States and approximately 80 or 90 that may be classified as hyperthermal. These latter ones occur in Oregon, Idaho, California and Nevada and within approximately 10% of the total area of the United States.

All but 5 of the above noted hyperthermal springs and areas are situated within or near enough to Pliocene or Quaternary volcanism to reasonably conclude that they are directly associated with such phenomena. Injected magmas which still retain much of their initial heat are believed to be the principal and possibly the sole source of hyperthermal emanations.

Avenues of escape for gases and liquids from the magma or from the zone of abnormal heat created by an injected magma are afforded principally by faults and fractures in overlying rocks. Zones of high porosity and permeability in rocks adjacent to the heat zones may also have an important role in the process.

Prospecting for hyperthermal areas may well be confined to superficial observations in areas of geologically late volcanism. Structural features, principally faulting of any type, are important. Geophysical surveys may become valuable adjuncts to areal and structural geological studies.

Prospecting for production in areas of hyperthermal activity must be done by drilled wells. Most of the techniques employed in oil-well drilling, particularly those employed in obtaining subsurface information on lithology, porosity, permeability, and temperature are required for a successful operation. All such drilling should be conducted under constant competent geological and engineering direction.--Auth. summ.



3-2638. Pemberton, Roger H. GEOPHYSICAL SURVEY COVERAGE IN CANADA: *Can. Mining Jour.*, v. 82, no. 4, p. 84-88, 3 illus., map, graph, Apr. 1961.

Public use of geophysical data has been restricted by the confidential nature of privately sponsored surveys. Recent and proposed legislation in Manitoba, Saskatchewan, and the Northwest Territories indicate broader access to data through permitting assessment credit for aerial geophysical surveys for which a record is submitted to the government.

## 7. GEOCHEMISTRY

See also: Stratigraphy 3-2569, 3-2570; Mineralogy 3-2698 through 3-2705, 3-2707 through 3-2712; Igneous and Metamorphic Petrology 3-2728; Geohydrology 3-2741, 3-2742; Mineral Deposits 3-2765, 3-2766, 3-2767, 3-2776.

3-2639. Myers, Alfred T., and others. A SPECTROCHEMICAL METHOD FOR THE SEMIQUANTITATIVE ANALYSIS OF ROCKS, MINERALS, AND ORES: *U.S. Geol. Survey, Bull.* 1084-I, p. 207-229, graph, 11 tables, 1961, 8 refs.

A visual comparison method for semiquantitative spectrochemical analysis of a powder by d-c arc technique is described. This method has been applied to a wide variety of geological materials, including rocks, minerals, and ores. As 68 elements are routinely looked for, the method has proven useful for the detection of elements not suspected of being present in the samples analyzed. The speed of the analysis and the method of reporting results to 1/3 of an order of magnitude have made this procedure of great value in reconnaissance studies. A total-energy technique is used. Large matrix effects are eliminated between samples and the standards used for comparison, by the addition of graphite to both samples and standards; silica is added to samples only if the samples are low in silica content. The plate-emulsion error is minimized by a light-intensity adjustment for each new batch of plates. The limits of detection and spectral lines used for analysis are shown for 68 elements. The elements are grouped so that only 20 sets of standards are required. Detailed examples for the preparation of the standards are given. A total of 682 comparisons are made between results by this semiquantitative spectrochemical method and by quantitative methods. This comparison shows that the semiquantitative spectrochemical results reported in intervals of 1/3 order of magnitude may be expected to include the quantitative value at least 60% of the time.--Auth.

3-2640. MacDougall, J. F., and others. EXPERIMENTAL INVESTIGATION OF SOLID DIFFUSION AND VOLATILIZATION OF CERTAIN METALLIC SULFIDES: *Econ. Geology*, v. 56, no. 2, p. 362-391, 16 figs., March-Apr. 1961, 20 refs.

The results of 96 experiments to investigate the behavior of "nonvolatile" sulfides below their melting points and in the absence of free O are reported.

Cylindrical pellets of copper sulfide heated in contact with similar pellets of iron sulfide, in N<sub>2</sub>, reacted at temperatures above 300°C. to form layers of bornite and chalcopyrite, mainly in the FeS pellets. The thickness of the layers of reaction products increased with time and temperature. Rock

The federal government and many of the provincial governments have made airborne magnetometer surveys for general distribution. The Saskatchewan government has also begun an electromagnetic program.

Comments are made on the application of the laws of probability to geophysical search. Examples are included in which the probability of discovery is balanced against dimensions of ore bodies and flight-line spacing. A special appraisal is given for geophysical anomalies in the Mattagami district, Quebec.--W. C. Peters.

discs placed between 2 such pellets were veined by chalcocite. Pyrite grains were replaced by chalcocite, bornite, and chalcopyrite.

Copper sulfide heated with Fe-rich chlorite showed some reaction at 550°C., but biotite, epidote, bronzite, augite, siderite, and calcite showed none.

CuS heated at 300°C. and at higher temperatures, recrystallized to chalcocite and digenite. If placed in a temperature gradient above this temperature, it also moved toward the lower temperature at a very appreciable rate. If excess S was removed, no appreciable migration occurred. Iron sulfide and a mixture of CuS and PbS also showed appreciable movement in similar circumstances.

Volatile transfer of Fe and Cu from sulfides was recorded at 550°C. for Fe and 675°C. for Cu.--Auth.

3-2641. Malinin, S. D. THE SYSTEM WATER-CARBON DIOXIDE AT HIGH TEMPERATURES AND PRESSURES: *Geokhimiya*, in translation, 1959, no. 3, p. 292-306, 9 figs., 2 tables, pub. 1960, 11 refs.

The study of the solubility of carbon dioxide in the liquid phase of water in the region of temperatures from 200 to 300°C. (in one separate case to 330°C.) and pressures from 100 to 500 kg./cm.<sup>2</sup> is in supplement to the data of the literature which is bounded at the temperature of 120°C.

According to the data of the compositions of the gaseous phase, in equilibrium with the liquid phase, a general diagram of the system water-carbon dioxide was constructed for temperatures from 50° to the critical temperatures.

Comparison with the diagram liquid-gas for the system sulfur dioxide-N according to the literature data discloses their similar character. In both cases, the pressure lowers the temperature of the critical transfer of the system and gives a basis to surmise by analogy the presence of a maximum on the curve of solubility of the gas carbon dioxide in the liquid phase of water and of the minimum in the curve of solubility of the vapor of water in the gas of carbon dioxide at corresponding temperatures.

It is shown that the equations of solubility of a gas in the liquid are applicable to the system water-carbon dioxide to 250°C.

In the example of 10% water solution of calcium chloride, part of the system was studied: the water salt solution-carbon dioxide in the ranges 100-400 kg./cm.<sup>2</sup> and 200 to 300°C.

The solubility of carbon dioxide in 10% solution of calcium chloride is 1.5-2.5 times less than in pure water; however the general course of the curves of solubilities are similar in general characteristics.

In natural solutions, it is necessary to expect as great a variety in respect to the composition of the salts contained in them as in their concentrations,

therefore, the question about the phase relationships in them is rather complicated and requires special descriptions in each separate case. As regards water with calcium chloride content in it of the order of 10% or less, then the solubility of carbon dioxide in it is acknowledged to be very significant.

The general considerations developed in relation to the diagram of water-carbon dioxide apparently are also valid to a certain extent for the systems with salt solutions.--Auth. concl.

3-2642. Muan, Arnulf, and Shigeyuki Sōmiya. STABILITY RELATIONS OF IRON AND MANGANESE MINERALS: PHASE EQUILIBRIA AT LIQUIDUS TEMPERATURES IN THE SYSTEM IRON OXIDE-MANGANESE OXIDE-SILICA IN AIR: Am. Mineralogist, v. 46, no. 3/4, p. 364-378, 8 figs., March-Apr. 1961, 12 refs.

The quenching technique has been used to study phase relations in the liquidus temperature region of the system iron oxide-manganese oxide-silica in air, which represents the 0.21 atm.  $O_2$  isobaric section through the quaternary system Fe-Mn-Si-O. The following crystalline phases exist in equilibrium with liquids in the system: silica (cristobalite or tridymite, depending on temperature), rhodonite ( $MnO \cdot SiO_2$ ), tephroite ( $2MnO \cdot SiO_2$ ), spinel solid solution (approximately  $Fe_3O_4$ - $Mn_3O_4$ ). Dominant among the primary phase areas are those of silica and spinel, whereas the stability fields of rhodonite and tephroite are restricted to minor areas adjacent to the manganese oxide-silica join. An area comprising mixtures giving rise to 2 coexisting immiscible liquids occupies a large part of the diagram. Liquidus temperatures in general decrease from the iron oxide-silica join to the manganese oxide-silica join. The lowest liquidus temperature in the system in air is 1,205°C. Paths of crystallization of representative mixtures are discussed, with special emphasis on the complications arising because of the presence of a temperature minimum on the liquidus curve of the bounding system iron oxide-manganese oxide.--Auth.

3-2643. Zen, E-an. THE ZEOLITE FACIES: AN INTERPRETATION: Am. Jour. Sci., v. 259, no. 6, p. 401-409, 2 figs., June 1961, 25 refs.

The zeolite facies, formed under conditions intermediate between diagenesis and regional metamorphism, is characterized by mineral assemblages bearing laumontite, heulandite, or analcite, together with quartz. If  $H_2O$  and  $CO_2$  are regarded as mobile components, these assemblages, under the same conditions, rule out the following: calcite-kaolinite-quartz, calcite-pyrophyllite-quartz, or albite-quartz; these assemblages are all familiar in sediments, sedimentary rocks, or low-grade regional metamorphic rocks.

The relations among these alternative assemblages are analyzed by means of isothermal, isobaric diagrams using as variables the chemical potentials of the 2 mobile components,  $H_2O$  and  $CO_2$ . For a given reaction, it is not only possible to arrange correctly the relative dispositions of the pseudo-univariant around pseudo-invariant points, but also to assign numerical values to the slopes of the pseudo-univariant lines on the basis of the stoichiometric coefficients of the 2 mobile components. Such diagrams show that mineral assemblages of the zeolite facies can be obtained, isothermally and isobarically, by increasing the chemical potential of  $H_2O$  relative to

that of  $CO_2$ . Thus the zeolite facies is not a necessary intermediate step between diagenesis and regional metamorphism.--Auth.

3-2644. Starik, I. E., and others. THE AGE OF TEKTITES: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 9, p. 80-81, pub. 1961, 2 refs.

A Tertiary tektite, of Indochinite, was analyzed by the Pb-isotope method and found to be  $3.7 \times 10^9$  years old; this constitutes additional evidence for the cosmic origin of tektites.--M. Russell.

3-2645. Osipova, G. A. MIGRATION OF COMPONENTS DURING THE FORMATION OF SKARNS AT THE TASHBULAK DEPOSIT: Geokhimiya, in translation, 1959, no. 1, p. 33-43, 4 figs., 4 tables, pub. 1960, 3 refs.

In the process of skarn formation at the Tashbulak deposit, substantial amounts of  $SiO_2$ ,  $Al_2O_3$ , and  $Fe_2O_3$  were introduced with postmagmatic solutions, rather than contributed by the igneous rocks in the course of bimetasomatism. The latter mechanism has been described by Korzhinsky for a number of cases with similar geological settings. On the other hand, our endorsement of postmagmatic metasomatism is in agreement with the conclusions of Karpova and Ivashentsov.

The introduction and removal of the main skarn-forming components ( $SiO_2$ ,  $Al_2O_3$ , CaO) are observed in the outer contact zones but are inconspicuous at the inner contacts. Therefore, the chemical composition of endoskarms depends almost entirely on the composition of the intrusives, while that of the exoskarms is determined by addition and subtraction of the main skarn-forming constituents.

The composition of the exoskarms is the same for all igneous rocks, but each igneous rock is characterized by a specific assemblage of endoskarn minerals. Granodiorite porphyries are characterized mainly by pyroxene, garnet (rarely idocrase), followed by epidote, chlorite, quartz, and calcite; pyroxene lamprophyres, by urallite, followed by epidote, chlorite, quartz, and carbonate; spessartites, by actinolite, pyroxene pseudomorphs after amphibole, albite, then epidote, chlorite, quartz, and carbonate; ker-santites, by epidote, chlorite, quartz, carbonate; diabases, by epidote, chlorite, quartz, and carbonate.--Auth. summ.

3-2646. Balasanyan, S. I. THE AVERAGE COMPOSITION OF THE IGNEOUS ROCKS OF ARMENIA: Geokhimiya, in translation, 1959, no. 3, p. 279-291, fig., 11 tables, 1960, 2 refs.

Resemblances and differences have been found between the principal rock types of Armenia and Daly's average rocks. The differences between the average composition of Armenian igneous rocks and Daly's average rocks are more clearly revealed by Zavaritsky's numerical characteristics (especially auxiliary ones) than by analyses. In general, the average composition of the intrusives of Armenia is characterized by a higher  $Al_2O_3$  content and lower  $SiO_2$ ,  $Na_2O$ , and ( $Na_2O + K_2O$ ) content. Most of the extrusive rocks of Armenia have lower content of  $TiO_2$  and ( $Fe_2O_3 + FeO$ ).

In general, the average composition of the intrusives differs from that of their extrusive equivalents by higher FeO, MgO, and CaO content and lower



$\text{Fe}_2\text{O}_3$  and  $\text{Na}_2\text{O}$  content. The average composition of Armenian intrusives is more silicic and alkalic than the average composition of the extrusives. The average composition of the igneous rocks of Armenia is near diorite and basaltic andesite. The average composition of Armenian intrusives is more mafic and often less alkalic than the average composition of analogous rocks from other regions of the U.S.S.R. The average composition of Armenian extrusives differs from that of the other regions of the U.S.S.R. (except those of the Caucasus) in being richer in alumina.

The Armenian igneous rocks averages are more mafic than the average composition of other regions of igneous complex in the U.S.S.R. The igneous complex of Armenia is distinguished by a lower Si clark and often a lower K clark, but it has a higher Al clark and often higher Fe, Mg, and Ca clarkes than the igneous complexes of the other regions of the U.S.S.R. The clarkes of some petrogenic elements in the igneous complex of Armenia are similar to those in the igneous complexes of the Caucasus, the Urals, and the Far East.

In the igneous complexes of the U.S.S.R., the clark of Na is rather constant but the clark of K is more or less variable.

The crust in the territory of Armenia has a somewhat higher Ca, Fe, and Al and a lower Ti and K clark than that of the earth's crust. The clarkes of the more abundant elements diminish in Armenia in the same sequence as in the earth's crust as a whole.--Auth. summ.

**3-2647.** Zhiron, K.K., and I.V. Chernyshev. ON THE GEOCHEMISTRY OF LEAD IN THE DEVONIAN EXTRUSIVES OF CENTRAL KAZAKHSTAN: *Geokhimiya*, in translation, 1959, no. 2, p. 141-150, 3 figs., 4 tables, pub. 1960, 13 refs.

The Pb content in the Devonian extrusives of the investigated regions of central Kazakhstan is lower than the clarkes for the igneous rocks of the corresponding types. There is no observable enrichment in Pb of the acid varieties of rocks. The slightly higher Pb content in the extrusives of Mt. Terekta suggests regional variation. Some samples of rhyolite tuffs are enriched in Pb as compared with the samples of lavas of equivalent composition. This enrichment is most likely secondary.--Auth. summ.

**3-2648.** Borisenko, L.F., and N.V. Lizunov. THE OCCURRENCE OF SCANDIUM AND SOME OTHER RARE ELEMENTS IN CASSITERITE: *Geokhimiya*, in translation, 1959, no. 1, p. 76-82, fig., 3 tables, pub. 1960, 8 refs.

Sc occurs in considerable amounts (up to 0.2%  $\text{Sc}_2\text{O}_3$ ), mainly in the cassiterites from pneumatolytic-hydrothermal deposits of the greisen type, and is almost never found in cassiterites from pegmatites and sulfide-cassiterite deposits.

All Sc-bearing cassiterites contain Nb (up to 2-3%  $\text{Nb}_2\text{O}_5$ ), W, and Zr, and many of them contain Ta (hundredths and tenths of 1%). However, not all Nb-bearing cassiterites contain Sc. The presence of Nb in cassiterites does not necessarily indicate the presence of Sc. Especially noteworthy in this respect are the pegmatitic cassiterites.

It is most probable that Sc ( $\text{Sc}^{3+}$ ) enters into cassiterite by diadochically replacing Sn ions ( $\text{Sn}^{4+}$ ). The charge is balanced by the substitution of a part of the Sn ions by Nb ions ( $\text{Nb}^{5+}$ ).--Auth. summ.

**3-2649.** Rekharsh, V.I. ON THE REGULARITIES OF DISTRIBUTION OF MOLYBDENUM AND U-

RANIUM IN MINERALIZED ZONES: *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 8, p. 17-27, 11 figs., pub. 1961, 15 refs.

The author deals with the problem of regularity of distribution of Mo and U in mineralized zones. Molybdenite, pitchblende, and uraninite were often found in the same Mo and U ore deposits. The author also observed the simultaneous occurrence of these minerals in mineralized zones usually formed of different hydrothermally metamorphosed rocks associated with a variety of acid intrusive and extrusive Paleozoic granite-porphyrries, quartz porphyries, felsites, quartz syenite-porphyrries, and dacite-porphyrries. Thin fissures of these mineralized zones are filled with pyrite, molybdenite, pitchblende, calcite, galenite, sphalerite, chalcopyrites, sericite, quartz, albite, fluorite, and barite. Of all these minerals, molybdenite and pitchblende are most often found together and either form molybdenite-pitchblende veins or form a collomorphic secretion together with galenite, pyrite, sphalerite, calcite, and other minerals.

Molybdenite usually surrounds grains of pitchblende, and a microscopic study showed that in some slides a gradual transition from molybdenite to pitchblende can be observed; the author supposes that such formations are a product of coagulation of complexly composed gels which separated into different minerals in the process of aging. Calcite, albite, and galenite are most often found in paragenetic association with pitchblende and sericite and quartz (with Mo). Pyrite is also paragenetically related to both minerals. Metamorphic occurrence of these minerals and the regularity of their occurrence in relation to the character of transformation of enclosing rock formations is described. These minerals were secreted from the solution almost at the same time, and there is a close connection between the mineral-forming process and the process of hydrothermal metamorphism of the enclosing rock formations.

The author suggests that the concentration of Mo occurs in zones of sericitized and silicified rock where the formation of the second generation sericite occurs simultaneously with that of metasomatic sericite developing in the oligoclase. Such concentration also occurs in zones of transition of sericitized and silicified rock into albitized and carbonate rocks. As to U, its highest content is associated with zones of intensely albitized and carbonate rock. An increase in U from the lower to the upper part represents the optimum conditions of sedimentation of uranium oxides from the hydrothermal solutions.--From LC.

**3-2650.** Krylov, A.Ya., and L.Ya. Atrashenok. THE MODE OF OCCURRENCE OF URANIUM IN GRANITES: *Geokhimiya*, in translation, 1959, no. 3, p. 307-313, 3 tables, pub. 1960, 10 refs.

Results are reported of leaching rocks and minerals with 0.2N solution of  $\text{Na}_2\text{CO}_3$  for their U content. Five classes of granites from the Tien Shan were sampled: 1) slightly altered granites, 2) greisenized granites, 3) chloritized granites, 4) granites with uranium titanate, and 5) granites with uranium oxides and secondary U minerals. Tests were made to determine the degree of leaching of different minerals. It is concluded that in rocks or minerals possessing high U leachability, U is present in the form of secondary minerals and oxides; in common granites, not altered by postmagmatic processes, U occurs in the finely dispersed accessory minerals.--M. Russell.

3-2651. Naumov, G. B. TRANSPORTATION OF URANIUM IN HYDROTHERMAL SOLUTION AS A CARBONATE: Geokhimiya, in translation, 1959, no. 1, p. 5-20, 5 figs., table, pub. 1960, 20 refs.

Complex uranyl carbonate anions exist under natural conditions, and the hypothesis of U transport in hydrothermal solutions in the form of carbonates meets with no objections from the physicochemical point of view. The stability of the uranyl carbonate anions at elevated temperatures suggests that this is also the form in which U exists in the natural hot carbonate waters, at least up to the temperature of 150°C. The solutions may be alkaline, neutral, or possibly even weakly acid. The natural carbonate waters containing complex uranyl carbonate anions may be of the bicarbonate, sulfate, chloride, or mixed type.

Decrease in the oxidation-reduction potential of the U<sup>VI</sup>-U<sup>IV</sup> equilibrium with increase in the amount of carbon dioxide dissolved in water is of great geochemical importance. The accumulation of U in nature is favored by the following factors: 1) Reduction of carbon dioxide pressure and consequent decrease in the concentration of CO<sub>2</sub> dissolved in water. 2) Decrease in the alkalinity of solutions leading to decrease in the concentration of CO<sub>3</sub><sup>2-</sup> and, therefore, to increase in UO<sub>2</sub><sup>2+</sup> ions. 3) The precipitation of carbonate ion caused by a decrease in the concentration of carbon dioxide in the solution resulting from chemical reactions. 4) Decrease in the oxidation-reduction potential in connection with change in the composition of the enclosing rocks.--M. Russell.

3-2652. Nesterenko, G. V. BEHAVIOR OF TITANIUM DURING THE FORMATION OF SKARNS AT THE TYRNY-AUZ ORE DEPOSIT: Geokhimiya, in translation, 1959, no. 2, p. 196-202, 3 tables, pub. 1960, 7 refs.

Data on the distribution of Ti and mode of its occurrence in the country rocks and in products of their replacement at the Tyrny-Auz deposit may be summarized as follows:

1) During the process of skarn formation in marbles and biotite hornfels, no Ti was introduced by solutions; it was contributed to the skarns by biotite hornfels undergoing replacement. In the latter, it occurs not only in biotite but also in ilmenite. In the metasomatic rocks, Ti becomes fixed in sphene.

2) The replacement of biotite hornfels is accompanied by a partial removal of Ti into the plagioclase and quartz-plagioclase veinlets characteristic of pyroxene hornfels and pyroxene-garnet skarns.

3) Besides entering into ilmenite and sphene, Ti ionically substitutes for Al and possibly for Si in a number of other minerals.--Auth. concl.

3-2653. Vainshtein, E. E., and others. THE Hf/Zr RATIO IN ZIRCONS FROM GRANITE PEGMATITES: Geokhimiya, in translation, 1959, no. 2, p. 151-157, 2 tables, pub. 1960, 9 refs.

As the pegmatitic process develops, the ZrO<sub>2</sub>/HfO<sub>2</sub> ratio changes regularly. The later the minerals of the zircon group in pegmatites, the greater is their concentration of HfO<sub>2</sub> and the lower the ZrO<sub>2</sub>/HfO<sub>2</sub> ratio. The early pegmatitic zircons forming before the beginning of the replacement processes do not differ in their HfO<sub>2</sub> content and ZrO<sub>2</sub>/HfO<sub>2</sub> ratio from granitic zircons. In the pegmatites genetically related to alkalic syenites or quartz

syenites, the ZrO<sub>2</sub>/HfO<sub>2</sub> ratio in the zircons rises sharply. Thus, from the ZrO<sub>2</sub>/HfO<sub>2</sub> ratio it is possible to judge, to a certain extent, of the genetic connection between a pegmatite and an intrusive.

The metasomatic zircons found in granite pegmatites are quite different in their ZrO<sub>2</sub>/HfO<sub>2</sub> ratio from the pneumatolytic-hydrothermal zircons of ore veins. In the former the ZrO<sub>2</sub>/HfO<sub>2</sub> ratio ranges from 3 to 20 while in the latter, as shown in previous papers, it ranges from 25 to 45 and averages 30. Therefore, the Zr/Hf ratio makes it possible to distinguish between the zircons of albitized pegmatites and the zircons of albitites.

The latest zircons crystallizing in the last stages of emplacement of pegmatites have the highest HfO<sub>2</sub> content, reaching 14%, and may be regarded as independent Hf minerals.--Auth. summ.

3-2654. Eskova, E. M. GEOCHEMISTRY OF Nb AND Ta IN THE NEPHELINE SYENITE MASSIFS OF THE VISHNEVYIE MOUNTAINS: Geokhimiya, in translation, 1959, no. 2, p. 158-170, map, 5 tables, pub. 1960, 7 refs.

A number of general conclusions concerning the geochemistry of Nb and Ta in the nepheline syenites of the Vishnevyye mountains, U.S.S.R., can be drawn from the material presented above.

1) The nepheline syenites of the Vishnevyye mountains are characterized by a relatively high Nb and Ta content which is approximately 10 times as high as their content by weight in the igneous rocks in general. The Nb/Ta ratio in the alkalic rocks of the Vishnevyye mountains varies from 10.6 to 11.8.

2) The miaskites have the maximum average Nb and Ta content among the rocks of the Vishnevyye mountains. The average content of these elements decreases regularly from miaskites to the biotite and aegirine-augite syenites. The average Nb and Ta content in the granite gneisses is 1/10 of that in the alkalic intrusives.

3) A relatively high content of Nb and Ta in the nepheline syenite massifs of the Vishnevyye mountains is localized in the strongly albitized contact zones between miaskites and aegirine-augite syenites.

4) A considerable part of Nb and Ta (40-50%) in the nepheline and alkalic syenites is concentrated in Ti and Ti-bearing minerals (ilmenite, sphene, and biotite), in which Nb and Ta substitute diadochically for Ti. Nb and Ta are absent from minerals which do not contain Ti. The Nb<sub>2</sub>O<sub>5</sub> and Ta<sub>2</sub>O<sub>5</sub> content in the Nb-bearing minerals decreases gradually from miaskites to the biotite and aegirine-augite syenites.

5) The formation of the independent Nb mineral, pyrochlore, in the latest stages of crystallization of miaskites and biotite syenites was favored by the relatively low concentration of Ti in the alkalic magma and by the limited diadochy between Nb and Ta and Ti in the early stages of crystallization.

6) The main difference in the geochemical behavior of Nb and Ta and Ti is in the fact that Ti entered into the rock-forming minerals and formed its own minerals at the earlier stages of the crystallization of nepheline syenites, while a considerable part of Nb and Ta remained in the melt.

7) During the crystallization of the nepheline syenites of the Vishnevyye mountains, there occurred both absolute and relative concentration of Nb and Ta as compared with Ti. In the alkalic rocks of the Vishnevyye mountains, in contradistinction to the apatitic nepheline syenites, Zr did not noticeably influence the geochemical behavior of Nb and Ta.--Auth. concl.



3-2655. Gerasimovsky, V.I., and V.I. Lebedev. DISTRIBUTION OF RUBIDIUM AND LITHIUM IN ROCKS OF THE LOVOZERO MASSIF: *Geokhimiya*, in translation, 1959, no. 1, p. 71-75, table, pub. 1960, 3 refs.

Preliminary investigations of the distribution of Rb and Li in nepheline syenites of the Lovozero massif show that: a) Li and Rb are very irregularly distributed in the rocks of the massif, due mainly to the very variable composition of the rocks; b) there is no direct relation between the content of Rb and K and between the content of Li and Mg; c) the accumulation of Rb and Li occurs at the end of the magmatic process (in the rocks of the third intrusive phase); d) Li is a characteristic element in the Lovozero massif.--Auth. concl.

3-2656. Slepnev, Yu.S. THE CHARACTERISTICS OF DISTRIBUTION [sic] OF SOME RARE ELEMENTS [sic] IN METAMORPHIC ROCKS, GRANITES, AND RARE METAL PEGMATITES OF THE SAYAN MOUNTAINS: *Geokhimiya*, in translation, 1959, no. 3, p. 314-321, graph, 2 tables, pub. 1960.

In the pegmatites the content of Li and Be increases almost a hundredfold, and of Rb four- to fivefold, as compared with granites (Cs was not found in granites). These elements are concentrated during the early stages of the pegmatitic process. The maximum amount of Li (1.01%) was found in the quartz-spodumene complex, of Rb (0.342%) and Cs (0.015%) in the microcline complex, and of Be (0.03%) in the quartz-spodumene complex.

At the late stages of the pegmatitic process (albitization), the amount of Li decreases sharply (0.04%) and so do the amounts of Rb and Cs. The Be content remains the same (0.03%). The sharp diminution in Li, Rb, and Cs content in pegmatites is due to the development of Na metasomatism, which affects microcline especially and aids in the removal of these elements. During metasomatism, Be is merely redistributed in the pegmatite bodies. It forms disseminated crystals of beryl and, as shown by spectrographic analysis, enters into the lattices of a number of minerals (albite, 0.02%; tourmaline, 0.1%; etc.).

The content of Li increases from the 2-mica granites (0.004%) to the biotite granites (0.007%) and hornblende granites (0.012%).

The sum of the alkalis (K, Na, Li, Rb, and Cs) in pegmatites (5.65%) is nearly the same as in granites (5.17%) but the content of Na, Li, Rb, and Cs in pegmatites is higher than in granites. The K content is lower in pegmatites than in granites.

The average Rb and Cs content increases from schists to amphibolites, granites, and pegmatites and so the K/Rb ratio decreases from schists (163) to granites (119) and pegmatites (23).

In pegmatites the maximum and minimum Rb content correspond to the maximum and minimum Cs content (the curves of Rb and Cs content are almost identical in form). The Rb/Cs ratio in pegmatites is about 10 to 1.--Auth. summ.

3-2657. Getting, R.V., and E.N. Savinova. DISTRIBUTION OF BORON IN ROCKS AND SKARN MINERALS OF THE VADIMO-ALEKSANDROVSK DATOLITE LOCALITY (TURLIN MINERALIZED AREA, NORTHERN URALS): *Geokhimiya*, in translation, 1959, no. 1, p. 44-51, 6 tables, pub. 1960, 14 refs.

At the deposit, B is concentrated in hornfelses in garnets from the garnet-wollastonite skarns, in

epidotes and also in igneous and near-skarn rocks. The enrichment of the argillaceous and siliceous sediments in B and the high B content of sponge spicules suggest that the B in the hornfelses formed from the calcareous-argillaceous and calcareous-siliceous spicule-bearing shales is primary and not a contribution from the magma.

During the process of near-skarn alteration, no B is contributed by the igneous rocks. The presence of B in wollastonites is due to a mechanical admixture of datolite. The garnets from the garnet skarns do not, as a rule, contain B. The process of epidotization is accompanied by an addition of B and its fixation in epidote.

The absence of B skarn minerals is explained by the facts that in the process of skarn formation B behaves as a completely mobile component and that its chemical potential is low. The formation of datolite is favored by the presence of siliceous material in the limestones. Only B is added during the formation of datolite, and not silica. The absence of B from garnet skarn zones is evidently not a criterion for judging of the presence of datolite in the skarns. The relatively high B content in garnets, on the other hand, is an important geochemical criterion and guide to datolite mineralization.--Auth. summ.

3-2658. Dunaev, V.A. DISTRIBUTION OF BORON IN SOME ROCKS OF THE URALS: *Geokhimiya*, in translation, 1959, no. 3, p. 339-344, 5 tables, pub. 1960, 10 refs.

It may be said that the B content in sedimentary rocks of the Urals is essentially similar to that reported by other investigators (V.M. Goldschmidt and others) from other parts of the earth's crust, and the same is true of metamorphic rocks. Some of the Uralian intrusives present an exception in having a slightly higher B content, sometimes reaching 0.01%.--Auth. concl.

3-2659. Kalita, A.O. DISTRIBUTION OF RARE EARTHS IN THE PEGMATITE MINERALS OF NORTHWESTERN AND SOUTHWESTERN KARELIA: *Geokhimiya*, in translation, 1959, no. 2, p. 171-177, graph, table, pub. 1960, 8 refs.

A geochemical study of the rare earths shows that in the process of pegmatitization the Ce earths are separated at the earlier stages of replacement, while the Y earths are concentrated during the later stages of mineral formation.

As a result of action of the late solutions on the selective Y minerals, "secondary" minerals are formed metasomatically which are characterized by a low content of Y earths. This is due, apparently, to the considerably greater mobility of the Y earths in solutions with a higher concentration of strong bases.--Auth. summ.

3-2660. Borisenok, L.A. DISTRIBUTION OF GALLIUM IN THE ROCKS OF THE SOVIET UNION: *Geokhimiya*, in translation, 1959, no. 1, p. 52-70, 2 figs., 12 tables, pub. 1960, 29 refs.

Data on the distribution of Ga in the different types of rocks show that it is somewhat irregular. The Ga content is lowest in the ultrabasic rocks and increases through basic, intermediate, and acid rocks to the maximum content in the alkalic rocks. Ga content is controlled mainly by the content of Al. There is an approximately tenfold increase in Ga

content from the ultrabasic to acid rocks, i.e., from 0.0002% to 0.0020%. The intermediate and basic rocks contain somewhat less Ga than the acid rocks. The increase in the concentration of Ga parallels the increase in the Al content in the rocks. The preliminary investigations on the distribution of Ga during the differentiation of a single magmatic chamber (as illustrated by the central Kazakhstan massif and the Susamyr batholith of the Tien Shan) show a great uniformity both in the absolute content of Ga and in the Ga/Al ratio.

The regional distribution of Ga also shows great uniformity, and it appears impossible to single out any "Ga provinces." Some regions are enriched in Ga because of the abundance of alkalic rocks and pegmatites in them and because of postmagmatic alteration of the igneous rocks (metasomatism, greisenization). Among such regions are the Kola peninsula, the Ukraine, the Yenisey range, Transbaikalia, and the Altai mountains. On the whole, there is an impression of great uniformity in the distribution of Ga, whatever the age, locality, or conditions of formation of the rocks. This is a manifestation of the intimate connection between Ga and Al. But Ga does not always follow Al in its geochemical history. There are cases in nature when the 2 elements become separated owing to the slight differences in their properties. Evidently Ga and Al separate both in acid and in alkaline environments.--M. Russell.

**3-2661.** Borisenok, L. A., and L. V. Tauson. **GEO-CHEMISTRY OF GALLIUM IN THE GRANITOIDS OF THE SUSAMYR BATHOLITH (CENTRAL TIEN SHAN):** *Geokhimiya*, in translation, 1959, no. 2, p. 178-185, graph, 2 tables, pub. 1960, 2 refs.

The distribution of Ga in the granitoids of the Susamyr batholith and among their minerals suggests certain conclusions concerning the basic geochemical behavior of Ga in granitoids.

Ga is a typical dispersed element which, during the magmatic stage of its history, has very close geochemical and crystal chemical affinity for Al. In granitoid minerals, Ga is found almost exclusively as a diadochic substitute in Al-bearing minerals. Because it has a somewhat larger ionic radius than Al, it enters preferentially into those minerals in which Al has sixfold coordination. If the proportions of different rock-forming minerals in the granitoids are considered, the feldspars, which contain from 60 to 70% of all Ga present in the rock, must be considered as the main carriers of this element. Nevertheless, micas and amphiboles, whose Ga content is always higher than that of the associated feldspars, must be regarded as true concentrators of Ga.

The distribution of Ga in the rocks of the main intrusive phase of the Susamyr batholith indicates that Ga content is almost constant in the rocks belonging to the same genetic series. A slight increase in Ga content is observed only in aplite dikes. For the entire exposed area of the Susamyr granitoids under consideration, the average Ga content is 17 p.p.m.

Within the boundaries of a single magmatic complex the Ga-Al ratio remains practically constant, and this must be regarded as a manifestation of the intimate geochemical relationship between these elements during the magmatic stage of their history.--Auth. concl.

**3-2662.** Sobolev, B. P., and A. V. Novoselova. **THE ROLE OF FLUORINE COMPOUNDS IN THE TRANSPORTATION OF BERYLLIUM AND THE FORMATION OF PHENAKITE:** *Geokhimiya*, in translation, 1959,

no. 1, p. 21-32, 7 figs., 3 tables, pub. 1960, 25 refs.

The conditions of formation of phenakite from beryllium oxides, silica and fluo-beryllates have been determined. It has been established that phenakite forms from BeO and SiO<sub>2</sub> in the presence of fluo-beryllates, as a result of heterogeneous reactions, with the participation of the gaseous phase. Because of the occurrence of "transport" reactions, phenakite may be "distilled" in the presence of fluo-beryllates. The probable mechanism of transfer of Be, Si, and O during a "transport" reaction is suggested. The characteristics of the paragenesis of phenakite in different types of deposits and the morphological similarity of the crystals of synthetic and natural phenakite suggest that fluo-beryllates play a leading role in the process of formation of endogenic phenakite.--Auth. summ.

**3-2663.** Dobrovolsky, V. V. **EPIGENESIS IN THE QUATERNARY DEPOSITS OF NORTHERN KAZAKHSTAN:** *Geokhimiya*, in translation, 1959, no. 2, p. 220-236, 6 figs., 7 tables, pub. 1960, 15 refs.

The Quaternary deposits of northern Kazakhstan are undergoing epigenetic change in a definite geographical environment (steppe). Of all interrelated epigenetic processes, the most important are soil formation and the formation of epigenetic minerals.

The soil process in the steppe zone causes a regular redistribution of elements in the soil profile. This redistribution is relatively slight. Much more significant is the redistribution of the elements due to geochemical processes, resulting in the formation of epigenetic structures and minerals. The epigenetic structures are concretions, crusts, powderlike accumulations and coatings. Mineralogically, these structures consist mainly of cryptocrystalline calcite and fine-grained gypsum. Halite, epsomite, astrakhanite, wattervilleite, and the Fe rich-halloysite group of minerals are present in smaller amounts; hydrogoethite and wad are still less abundant.

The composition of the epigenetic structures in the Quaternary deposits is sensitive to change in the natural landscape. In the environment of the steppe-forest subzone, calcareous epigenetic structures are dominant. In the semi-arid steppe subzone, gypsum structures predominate, and in the arid steppe subzone, the chlorine-sulfate structures increase.

The different epigenetic structures selectively accumulate certain trace elements. It was found that the main mass of trace elements in the Quaternary deposits occurs in the colloidal-dispersed fraction. Therefore, the greatest variety of composition of admixed elements is found in the epigenetic structures, whose origin is related, through exchange or metasomatic reactions, to the colloidal-dispersed fraction.--Auth. summ.

**3-2664.** Perelman, A. I. **CATAGENESIS:** *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 8, p. 8-16, 2 figs., 3 tables, pub. 1961, 17 refs.

The expression "catagenesis" was introduced into geochemistry by the late A. E. Fersman in 1922 and means "a combination of changes in sedimentary rocks caused by underground waters in a hypergene zone which circulate through petrographically and chemically different beds and strata of sedimentary rocks." A peculiarity of catagenesis is its irregular distribution in strata and its association with definite levels, beds, and structural lines. Catagenesis develops mainly in water-bearing levels and in zones



of their contact with water resistant rocks. Different phenomena of catagenesis were caused by determined chemical elements, which, infiltrating into a given level, conditioned the geochemical peculiarity of a given type of catagenesis. The author calls such chemical elements (also ions and chemical compounds) the typomorphic elements. Such elements are free O,  $\text{CO}_2$ ,  $\text{H}_2\text{S}$ , Cl,  $\text{SO}_4$ , Na, Ca, and others. He distinguishes 2 groups of such elements.

The first group is composed of typomorphic elements and compounds of aerial migration (O, carbon dioxide, hydrogen sulfide, methane, etc.). Their influence on catagenetic processes is very great and in many cases determines the geochemical type of catagenesis. There are 3 basic surroundings in which these processes occur: 1) Oxidizing surroundings where water contains free O and catagenesis occurs in conditions of an oxidizing surrounding with all its characteristic geochemical peculiarities. O is the typomorphic element. 2) Reducing surroundings, without  $\text{H}_2\text{S}$ . The water contains large quantities of  $\text{CO}_2$ , methane and other hydrocarbons. These conditions are favorable for the migration of  $\text{Fe}^{+2}$  and  $\text{Mn}^{+2}$ . The migration of Fe in reducing surroundings is especially characteristic of marshy soils of humid zones. As a result of this migration the soil acquires a dark-blue or a variegated ochreous-dark blue color. This results in gley. Similar processes occur also at great depth, only this change of color is not caused by the superficial soil process (swamping) but by the gleying action of the water from ancient water-bearing beds. The  $\text{CO}_2$  is the typomorphic element-gas and also partly the hydrocarbon. 3) Reducing surroundings, with  $\text{H}_2\text{S}$ . The water does not contain O and other oxidizers, but contains large quantities of  $\text{H}_2\text{S}$ , methane, and other hydrocarbons. The difference between the second and third groups consists mainly in the absence or presence of  $\text{H}_2\text{S}$ .

The second group of typomorphic elements is composed of elements and compounds of water migration infiltrating in the form of normal or colloidal solutions (chlorine-ion, sulfate-ion, hydrocarbonate-ion, Ca, Mg, Na, Si, etc.). These typomorphic elements and compounds determine the alkaline-acid conditions and the mineralization of natural waters. Each geochemical type of catagenesis is characterized by a combination of aerial and liquid migrants found together in the water and jointly acting on the rocks. On this basis a geochemical classification of catagenesis can be established. The types of catagenesis are usually well defined in any geological cross-section and often characterized by the color which depends on the accumulation of a specific typomorphic element. The author further describes some characteristic types of catagenesis and gleying. The gleying occurs in noncarbonaceous as well as in carbonaceous red-colored rocks. In the first case Mg, Ca, Fe, P, and other elements are intensively carried away; in the second, the same occurs but to a lesser degree. Fe and Mg from gley sometimes concentrate in adjacent beds of the same ancient water-bearing level. The formation of gley is characteristic for deposits of a cuprous sandstone type associated with the red-colored formations, such as large ore bodies of Urals, Donbass, Central Asia, and the Dzhezkazgan Cu deposits. Special attention should be paid to the catagenetic phenomena observed in sedimentary rocks during geological survey and prospecting operations and in lithological research. The study of catagenetic processes will eventually permit the development of prospecting methods which should be called, according to the author, paleohydrochemical methods.--From LC.

3-2665. Ronov, A. B., and A. I. Ermishkina. DISTRIBUTION OF MANGANESE IN SEDIMENTARY ROCKS: *Geokhimiya*, in translation, 1959, no. 3, p. 254-278, 10 figs., 3 tables, pub. 1960, 43 refs.

On the basis of the data considered in this paper, the following conclusions are drawn.

1) The Mn content in platform sediments varied periodically with the passage of geological time. As a rule, epochs of enrichment of sedimentary deposits with disperse Mn which correspond to the initial and final periods of the Caledonian, Hercynian, and Alpine sedimentation cycles were synchronous with Mn metallogenic epochs. The formation of sedimentary Mn ore deposits proceeded under conditions of a general enrichment of coeval sediments with disperse Mn.

2) The bulk of the Mn dispersed in sedimentary rocks is paragenetically related to Fe. The size of the Mn to Fe ratio in sedimentary rocks is close to that in magmatic rocks. Some change in this ratio in favor of Mn is noted in carbonate rocks. The processes of separating these 2 metals, which ultimately lead to the formation of Mn deposits, become apparent locally and occur for definite values of the physico-chemical parameters (pH and Eh) of the erosion and sedimentation medium.

3) Maximal Mn content is associated with coastal facies deposits. The amount of Mn in the rocks gradually diminishes from the coastal zone in the direction of the continent towards the continental and lagoon facies deposits and more sharply in the direction of the open sea towards the pelagic facies deposits. Such on the whole is the distribution scheme for sedimentary Mn deposits, the majority of which are concentrated in deposits in the coastal parts of ancient seas, while a small number is found in continental deposits and there is a complete absence from deposits in the open sea. The beginning of Mn deposits was not an isolated phenomenon cut off from the general redistribution of Mn in the sedimentation process, and proceeded against a background of higher Mn concentration clarkes, and not the opposite, as is supposed by N. M. Strakhov.

4) The distribution of Mn in the areas of platform sedimentation basins is determined by a complex of climatic and tectonic conditions on the surrounding dry land. On the type of climatic conditions and the routine of tectonic movements depend the intensity of the erosion processes acting on continental rocks, the amount of Mn extracted and the mobility of its compounds, the physico-chemical conditions in the transporting medium and the places where the increased concentrations of Mn are deposited in sediments. Under the conditions of a humid climate the increased Mn contents in the sediments shift in the direction of the open sea, while under the conditions of an arid climate, on the contrary, the zone of maximum Mn concentrations migrates in the direction of the continent. An additional powerful factor intervenes in the distribution of Mn in geosynclines, namely, volcanism.

5) The regularities that have been revealed have a practical significance and should be taken into account in carrying out geochemical searches for Mn ores in platform sediment accumulation basins. --Auth. concl.

3-2666. Gorham, Eville. CHLOROPHYLL DERIVATIVES, SULPHUR, AND CARBON IN SEDIMENT CORES FROM TWO ENGLISH LAKES: *Can. Jour. Botany*, v. 39, no. 2, p. 333-338, 3 graphs, March 1961, 8 refs.

Chlorophyll derivatives, S, and C exhibit similar trends in each of 2 sediment cores, one from the fertile Esthwaite Water and the other from the unproductive Ennerdale Water. In Esthwaite Water maximum levels of all 3 constituents were reached early in the course of lake development, while in Ennerdale Water maxima were attained much later, and, in the case of chlorophyll derivatives and S, were much lower than in Esthwaite. Relatively high optical densities of acetone extracts between 400 and 500 m $\mu$  suggest the presence of carotenoids in surface muds from Esthwaite Water. Much lower optical densities were recorded for this wave-length range in extracts of deeper sediments from Esthwaite and all sediments from Ennerdale. Low ratios of optical density at 410 m $\mu$  to density at 350 m $\mu$  are characteristic of surface sediments from infertile lakes such as Ennerdale Water, and of woodland soils. However, higher ratios near to those observed throughout the Esthwaite core were found in the deeper Ennerdale sediments, with the exception of the deepest sample.

Ratios of chlorophyll derivatives to C and of S to C were higher in the more fertile Esthwaite Water, although relatively low ratios during the earliest stages of development indicate that this lake may have been less fertile then. In Ennerdale Water the ratio of chlorophyll derivatives to C exhibited a much slower rise to maximum values than in Esthwaite, and these maxima were much the same as the early Esthwaite minima. The ratio of S to C was also consistently lower in Ennerdale Water.--Auth.

**3-2667.** Kropachev, A. M., and others. STRONTIUM IN THE GROUND WATERS OF LOW SALINITY IN THE MIDDLE PRE-URALS: *Geokhimiya*, in translation, 1959, no. 1, p. 112-116, 2 tables, pub. 1960, 4 refs.

Work has shown that Sr is widely distributed in the ground waters of the pre-Urals. Relatively high Sr content, up to 26 mg./l., was found in the Permian deposits, which are abundantly represented in the southeastern part of the Perm region.--From auth., p. 115.

**3-2668.** Horr, C. Albert, and others. URANIUM AND OTHER METALS IN CRUDE OILS. [PT.] A. METHODS OF ANALYSIS FOR URANIUM AND OTHER METALS IN CRUDE OILS, WITH DATA ON RELIABILITY: U.S. Geol. Survey, Bull. 1100, p. 1-15, 7 tables, 1961, 17 refs.

The content of U and other metals in crude oils ranges from a few tenths to several hundred parts per million. To concentrate these metals, crude-oil samples were prepared for analysis and reduced to ash by 2 methods: a) a modified A.S.T.M. method of dry ignition, and b) a wet oxidation followed by ashing. These 2 methods were compared by ashing duplicate samples of the same oil and determining the concentration of 15 trace elements in the ash by quantitative spectrochemical procedures. Results obtained by the 2 methods do not differ appreciably. The concentration of Cu, V, and Ni in the ash of 37 oils was determined by both the quantitative and semiquantitative spectrochemical procedures. A comparison of the results showed that more than 60% of the semiquantitative results for these 3 elements are in the same one-third order of magnitude as the quantitative results. U in the ash was determined fluorimetrically, and comparative results on several samples showed satisfactory agreement.

Based on the results of the above tests, the meth-

ods used for the study of 117 samples of crude oil and 16 samples of refinery residue as described in chapter B [see abstract below] were the modified A.S.T.M. method of dry ashing the oil, the fluorimetric determination of U, and the semiquantitative spectrochemical determination of the other metals in the ash of these oils.--Auth.

**3-2669.** Hyden, Harold J. URANIUM AND OTHER METALS IN CRUDE OILS. [PT.] B. DISTRIBUTION OF URANIUM AND OTHER METALS IN CRUDE OILS: U.S. Geol. Survey, Bull. 1100, p. 17-99, 39 figs., 3 pls. (2 in pocket), 8 tables, 1961, 62 refs.

A total of 120 samples of crude oil and 16 samples of refinery residue were collected from oil fields and refineries located in the western half of the United States. The oil and residue samples were reduced to ash; the U content of the ash was determined by fluorometric analysis and the content of other metals by emission spectrograph.

The U content in the ash of a majority of the samples is included in the range 0.0002 to 0.001%. The reported average U content in the crust of the earth is within this percentage range. In contrast, V and Ni contents in the ash of most of the samples are included in the range of 10 to 50%, which is several orders of magnitude greater than the reported V and Ni contents in the crust of the earth. The amounts of other metals in the ash of oil are similar to those in the crust of the earth; among these latter metals, Mo shows the greatest relative enrichment in the ash of crude oil.

Twenty classes of oil are designated on the basis of U. S. Bureau of Mines crude-oil analyses. The classes are numbered so that the smaller numbers indicate light paraffinic oils and the larger numbers indicate heavy naphthenic or aromatic oils. The V, Ni, Ga, and Mo contents of the ash of the several crude oil classes are significantly different and tend to increase in the heavier, more naphthenic or aromatic crude oils. Among the metals the U content varied least from oil class to oil class.

In further comparisons the V and Ni contents are found to be associated with N content, residual C content, and other items measured in crude-oil analysis. Ga and Co contents show a lesser association; Ti, Cr, and Mo seem to be slightly associated; and U and Cu seem to be unassociated.

The ratios of V to Ni of the oil samples are restricted to a small range of values, but tend to increase with increasing age of reservoir rock. V and Ni are thought to be present in crude oil mainly as porphyrins, which are organo-metallic complexes. Ga, Co, and Mo also are inferred to be present as organo-metallic complexes.

Tests indicate that crude oil can leach U from sandstone containing U minerals such as uraninite and carnotite, although the chemical process is unknown. The U content of crude oils, therefore, can be indicative of the U content in sandstone oil reservoirs.--Auth.

**3-2670.** Gulyaeva, L. A., and I. F. Lositskaya. INVESTIGATION OF GERMANIUM CONTENT IN THE PETROLEUMS OF THE SOVIET UNION: *Geokhimiya*, in translation, 1959, no. 2, p. 186-195, 8 tables, pub. 1960, ref.

Ge was found in the oils of all most important petroliferous provinces of the Soviet Union in the following amounts (average Ge content in grams per ton): Sakhalin 0.015; Azerbaidzhan 0.063; Fergana



0.034; Bashkiria 0.044; Tataria 0.053; Kuibyshev district 0.033; Orenburg district 0.150.--From auth. summ.

3-2671. Mueller, Robert F. OXIDATION IN HIGH TEMPERATURE PETROGENESIS: *Am. Jour. Sci.*, v. 259, no. 6, p. 460-480, 5 figs., 2 tables, June 1961, 24 refs.

A study has been made of a variety of metamorphic and magmatic rocks to determine how oxidative processes are reflected in their mineral assemblages. In this study particular attention is paid to solid solutions.

Field and experimental evidence agree with theory as to the responses of ferromagnesian solid solutions to compositional changes of the coupled gas phase. Typical of these responses are the increases shown by the ratios  $\text{Fe}_2\text{O}_3/\text{FeO}$  and  $\text{MgO}/(\text{MgO} + \text{FeO})$  with increasing  $\text{P}_{\text{O}_2}$ .

Attention is also directed to the consequences of the normally low values of  $\text{P}_{\text{O}_2}/\text{P}_{\text{H}_2\text{O}}$  to gaseous transport by bodily flow and diffusion in regional metamorphism.

Examples of oxidative and related processes are drawn from regionally metamorphosed Fe formations of Quebec and the Lake Superior region, from numerous contact metamorphic deposits, from the extrusives of the San Juan region of Colorado, and from other magmatic provinces. A thermodynamic unity of response to oxidative processes is shown by these different rock types.--Auth.

3-2672. Aleksandrov, S.M. GEOCHEMICAL CHARACTERISTICS OF ALTERATION OF LUDWIGITE ORES: *Geokhimiya*, in translation, 1959, no. 2, p. 211-219, 4 illus., 2 tables, pub. 1960, 8 refs.

The ludwigite ores in all magnesium-iron borate deposits of the Soviet Union have been altered by both deuteric and supergene processes; this is especially clearly shown by the Zheleznyi Kryazh deposit in eastern Transbaikalia.

Deuteric processes caused intensive ascharitization of ludwigite and subsequent replacement of ascharite by the later gangue minerals, serpentine, calcite, and others. In the zone of oxidation, ascharite was replaced by hydrous iron oxides and carbonatized. The replacement of the borates is characterized by certain regularities.--M. Russell.

3-2673. Germanov, A.I., and others. INVESTIGATION OF THE OXIDATION-REDUCTION POTENTIAL OF GROUND WATERS: *Geokhimiya*, in translation, 1959, no. 3, p. 322-329, 3 figs., table, pub. 1960.

From 1951 to 1957, more than 300 measurements were made of the oxidation-reduction potential of ground waters in Central Asia, Kazakhstan, and the Caucasus. Their Eh varies from +550 to -480 mv. In conjunction with the composition and amount of dissolved gases, the Eh value provides a good characteristic of the geochemical environment existing in a given area.--M. Russell.

3-2674. Baas Becking, L.G.M., and D. Moore. BIOGENIC SULFIDES: *Econ. Geology*, v. 56, no. 2, p. 259-272, 4 figs., 6 tables, March-Apr. 1961, 18 refs.

Experiments have been carried out at the laboratory of the Bureau of Mineral Resources in Canberra,

Australia, on the preparation of sulfide minerals by biological methods with the following results:

a) Covellite, digenite, argentite, sphalerite, and galena were prepared by bacterial sulfate reduction in artificial seawater on H and lactate media from carbonates, oxycarbonates and, in the case of Ag, from the chloride. Chrysocolla was also used.

b) While Ni and Co yielded black sulfides, powder diagrams yielded no identifiable mineral.

c) Rhodochrosite and mercuric carbonate did not produce sulfides.

d) Mixtures of iron and copper oxides always yielded iron sulfides plus covellite. Neither bornite nor chalcopyrite could be obtained.--Auth.

3-2675. Vinogradov, A.P., and others. ISOTOPE FRACTIONATION OF ATMOSPHERIC OXYGEN: *Geokhimiya*, in translation, 1959, no. 3, p. 241-253, 6 figs., map, 3 tables, pub. 1960, 12 refs.

The fractionation factor  $\alpha$  for the isotope fractionation of atmospheric O in the ocean is 1.010, while the fractionation of O in soil due to the increase in soil moisture is negligible.

The magnitude of the isotope fractionation of atmospheric O in the ocean and in soil is not sufficient to explain the difference between the isotopic composition of photosynthetic and atmospheric O.

We believe that the O isotopic composition of the atmosphere is a function of the  $\text{CO}_2$  content and varies with its concentration in the atmosphere. Hence, the isotopic composition of O in ancient oxides provides a means of estimating the concentration of carbon dioxide in the atmosphere at different periods during the history of the earth.--Auth. summ.

3-2676. Craig, Harmon. ISOTOPIC VARIATIONS IN METEORIC WATERS: *Science*, v. 133, no. 3465, p. 1703-1703, graph, May 26, 1961, 5 refs.

The relationship between deuterium and O-18 concentrations in natural meteoric waters from many parts of the world has been determined with a mass spectrometer. The isotopic enrichments, relative to ocean water, display a linear correlation over the entire range for waters which have not undergone excessive evaporation.--Auth.

3-2677. Craig, Harmon. STANDARD FOR REPORTING CONCENTRATIONS OF DEUTERIUM AND OXYGEN-18 IN NATURAL WATERS: *Science*, v. 133, no. 3467, p. 1833-1834, June 9, 1961, 6 refs.

A standard, based on the set of ocean water samples used by Epstein and Mayeda to obtain a reference standard for O-18 data, but defined relative to the National Bureau of Standards isotopic reference water sample, is proposed for reporting both deuterium and O-18 variations in natural waters relative to the same water. The range of absolute concentrations of both isotopes in meteoric waters is discussed.--Auth.

3-2678. Zhironov, K.K., and S.I. Zykov. THE ISOTOPIC COMPOSITION OF LEAD FROM CERTAIN DEPOSITS OF CENTRAL KAZAKHSTAN: *Geokhimiya*, in translation, 1959, no. 1, p. 92-98, 2 tables, pub. 1960, 10 refs.

The isotopic composition of 17 samples of Pb from 15 different deposits of central Kazakhstan has been studied.

A number of leads from Mn, rare metals, and hydrothermal deposits have identical isotopic composition.

It is possible that the polymetallic phase of mineralization in rare metals deposits is superimposed and may be genetically related to the formation of Pb, Pb-Zn, and other deposits.

Genetically related deposits located not far from one another have leads of different isotopic composition. It is probable that in these deposits and in the deposits within a given region the presence of 2 generations of galena will be established.--Auth. summ.

**3-2679.** Malinovsky, F.M. THE ISOTOPIC COMPOSITION OF LEAD FROM THE SULFIDE-BEARING PHOSPHORITES OF PODOLIYA: Geokhimiya, in translation, 1959, no. 2, p. 237-239, pub. 1960, 5 refs.

Sulfide-bearing phosphorite concretions from Cambrian-Silurian shales of Podoliya, Ukraine, have the following isotopic compositions of Pb from galena: 206/204 - 20.17±0.1; 207/204 - 15.98±0.1; 208/204 - 38.09±0.2. These are noticeably higher than is to be expected from tables of average values.--M. Russell.

**3-2680.** Chalov, P.I. THE  $U^{234}/U^{238}$  RATIO IN SOME SECONDARY MINERALS: Geokhimiya, in translation, 1959, no. 2, p. 203-210, 3 tables, pub. 1960, 6 refs.

The  $U^{234}/U^{238}$  ratio was determined in 44 samples of minerals collected from the zones of oxidation and secondary enrichment of an ore deposit. The equilibrium between  $U^{234}$  and  $U^{238}$  may be shifted

under natural conditions towards relative impoverishment of the minerals in  $U^{234}$ .--M. Russell.

**3-2681.** Baranov, V.I., and others. On the EXISTENCE OF ISOTOPE SHIFTS IN NATURAL THORIUM COMPOUNDS: Geokhimiya, in translation, 1959, no. 1, p. 83-91, 3 figs., 2 tables, pub. 1960, 11 refs.

The isotopic composition of Th in minerals may change. In most investigated minerals the isotopic composition corresponding to or near equilibrium is preserved. In some cases there is a noticeable impoverishment of the minerals (karnasurtite, steenstrupine) in  $Th^{228}$  which may be due to the leaching of  $Ra^{228}$  or  $Th^{228}$  by ground waters.

Experiments in leaching show that the change in the isotopic composition depends on the mineral subjected to leaching. For monazite the change is not so great as for thorite leached under the same conditions, in which the change in isotopic composition is due mainly to the leaching out of  $Th^{228}$ .--From auth., p. 86-88.

**3-2682.** Miyake, Yasuo, and Yukio Sugimura. IONIUM-THORIUM CHRONOLOGY OF DEEP-SEA SEDIMENTS OF THE WESTERN NORTH PACIFIC OCEAN: Science, v. 133, no. 3467, p. 1823-1824, table, June 9, 1961, 8 refs.

The rate of deposition of deep-sea deposits collected at the depths of 6,215 to 8,450 m. in the western part of the North Pacific Ocean was estimated by means of the ionium/Th ratio. The ratio was determined by an alpha-ray spectrometer. Results showed the rate of 0.5 to 0.8 mm./ $10^3$  yr. for the upper 10-cm. layer below the sea bottom.--Auth.

## 8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Stratigraphy 3-2561; Geochemistry 3-2662; Igneous and Metamorphic Petrology 3-2725; Mineral Deposits 3-2775.

**3-2683.** Gleason, Sterling. FOR QUICK MINERAL IDENTIFICATION: ULTRA-VIOLET LIGHT: Lapidary Jour., v. 14, no. 6, p. 510-513, Feb. 1961.

The use of UV in detection of a limited number of photoluminescent species is strongly advocated. Components of granular aggregates or crystals too small to be readily identified by conventional field methods may sometimes be certainly identified by use of portable UV sources. The fact that relatively few species do fluoresce is emphasized as an aid to identification. Prospecting with portable UV sources is described.--J. Sinkankas.

**3-2684.** DeCarli, Paul S., and John C. Jamieson. FORMATION OF DIAMOND BY EXPLOSIVE SHOCK: Science, v. 133, no. 3467, p. 1821-1822, June 9, 1961, 7 refs.

Samples of graphite have been recovered after exposure to explosive shocks of 300,000-atm. estimated intensity. X-ray and electron-diffraction examinations prove the existence of diamond in this material. The mechanism proposed for the formation of diamond under these conditions is simple compression in the c-axis direction of the rhombohedral form of graphite.--Auth.

**3-2685.** Cameron, Eugene N., and Ian M. Threadgold. VULCANITE, A NEW COPPER TELLURIDE

FROM COLORADO, WITH NOTES ON CERTAIN ASSOCIATED MINERALS: Am. Mineralogist, v. 46, no. 3/4, p. 258-268, 5 figs., table, March-Apr. 1961, 8 refs.

A copper telluride found in specimens from the Good Hope Mine, Vulcan, Colorado, has been determined to be a new mineral. It is named vulcanite, from the locality of the mine.

Vulcanite forms light bronze to yellow-bronze aggregates of prismatic or bladelike to irregular grains of metallic luster. One prominent cleavage and one less prominent are probably pinacoidal. Twinning nearly at  $45^\circ$  to the prominent cleavage is shown. Hardness is between 1 and 2; specific gravity is indeterminate owing to impurities. In polished section, vulcanite is strongly birefractant (reflectivity in white light is ca. 36.0% to 58.5%), varying from bright yellow to yellow-white to medium blue-gray. Extinction is parallel to cleavage and the long axes of laths. Rotation sense is (-) relative to the prominent cleavage. Anisotropism is very strong; polarization colors are yellow-white, grayish yellow-white, yellow-orange, gray. Phase difference in white light is (-); elongation on the prominent cleavage is (-). Rotation angles (corrected  $A_r$ ) range from  $17.2^\circ + 0.6^\circ$  at 470  $m\mu$  to  $24.7^\circ + 0.6^\circ$  at 650  $m\mu$ . Phase differences ( $2\theta$ ) range from  $58.6^\circ + 6.0^\circ$  at 470  $m\mu$  to  $-9.0^\circ + 1.8^\circ$  at 650  $m\mu$ . Microchemical tests show Cu and Te; etch tests are positive for 1:1  $HNO_3$ , 1:1  $HCl$ ,  $FeCl_3$ , and  $KCN$ , negative for  $H_2Cl_2$  and  $KOH$ .



X-ray powder diffraction data show that vulcanite is orthorhombic, with cell dimensions  $a=4.09 \text{ \AA}$ ,  $b=6.95 \text{ \AA}$ , and  $c=3.15 \text{ \AA}$ . These values are in close agreement with those found for synthetic CuTe by Anderko and Schubert. The probable space group is  $Pnmm$ .

Twinning and intergrowths in rickardite associated with vulcanite are described briefly. A second telluride, also apparently new, is briefly described pending further investigation.--Auth.

**3-2686.** Chao, Edward C. T., and others. NEIGHBORITE,  $\text{NaMgF}_3$ , A NEW MINERAL FROM THE GREEN RIVER FORMATION, SOUTH OURAY, UTAH: *Am. Mineralogist*, v. 46, no. 3/4, p. 379-393, 6 figs., 4 tables, March-Apr. 1961, 5 refs.

Neighborite,  $\text{NaMgF}_3$ , occurs in the dolomitic oil shale of the Eocene Green River formation of South Ouray, Uintah County. It is associated with dolomite and quartz and the accessory minerals burbankite, nahcolite, barytocalcite, garrelsite, wurtzite, calcite, and pyrite. The mineral occurs in pink rounded grains or in clear twinned octahedral crystals 0.1 to 0.5 mm. in diameter. It has a vitreous luster, uneven fracture, a hardness of 4.5, and is insoluble in water. The specific gravity is 3.03 (measured) and 3.06 (calculated). Neighborite is optically anisotropic with very low birefringence and a mean index of refraction 1.364. The crystals are invariably complexly twinned.

X-ray powder patterns show that neighborite is isostructural with perovskite,  $\text{CaTiO}_3$ . The pattern was indexed on an orthorhombic unit cell having a probable space group  $Pcmm$ , with dimensions  $a=5.363 \text{ \AA}$ ,  $b=7.676 \text{ \AA}$  and  $c=5.503 \text{ \AA}$ . The expansion of the unit cell was followed to  $954^\circ\text{C}$ . using a heating stage on the diffractometer. At  $760^\circ\text{C}$ . the orthorhombic  $a$  and  $c$  axes coalesce and from  $760^\circ$  to  $900^\circ\text{C}$ . the cell is tetragonal or pseudotetragonal with  $a=3.942 \text{ \AA}$  and  $c=3.933 \text{ \AA}$  (at  $760^\circ\text{C}$ .). At  $900^\circ+25^\circ\text{C}$ . the unit cell becomes cubic with  $a=3.955 \text{ \AA}$ . The crystal structure of neighborite is interpreted in terms of the known structure of perovskite.--Auth.

**3-2687.** Levinson, Alfred A. A POORLY CRYSTALLIZED, LOW BARIUM, PSILOMELANE-TYPE MINERAL: *Am. Mineralogist*, v. 46, no. 3/4, p. 355-363, 3 tables, March-Apr. 1961, 15 refs.

A poorly crystallized Mn mineral from Zacatecas, Mexico, is described. Its X-ray diffraction pattern gives only 3 distinct lines in addition to a few extremely weak bands and lines. The X-ray data indicate the specimen is a psilomelane-type mineral. Chemical analysis shows the mineral to be similar to psilomelane except that Ba is low ( $\text{BaO}=4.5\%$ ). Significant substitution of K, Na, Ca, and Sr takes place for Ba.

The nomenclature of psilomelane and psilomelane-type is reviewed. It is suggested that the term manganomelane be used as the general name for all hard manganese oxide minerals not specifically identified. Wad should continue to be used for soft manganese minerals not specifically identified.--Auth.

**3-2688.** Butler, J. R. THE CONSTITUTION OF DAVIDITE: *Econ. Geology*, v. 56, no. 2, p. 442-444, March-Apr. 1961, 6 refs.

Reply to a paper by J. D. Hayton (*GeoScience Abstracts* 2-3024). In addition to showing a peculiar

and diagnostic lanthanon distribution, davidites are chemically characterized by 1) a relatively high Sr/Ca ratio combined with a low alkaline earth content, 2) a relatively high U/Th ratio combined with a low  $\text{ThO}_2$  content.--From auth. concl.

**3-2689.** Mrose, Mary E., and others. NORSETHITE,  $\text{BaMg}(\text{CO}_3)_2$ , A NEW MINERAL FROM THE GREEN RIVER FORMATION, WYOMING: *Am. Mineralogist*, v. 46, no. 3/4, p. 420-429, 5 illus., 3 tables, March-Apr. 1961, 7 refs.

Norsethite,  $\text{BaMg}(\text{CO}_3)_2$ , was found in dolomitic black oil shale below the main trona bed in the Westvaco trona mine in Wyoming, associated with shortite, labuntsovite, searlesite, loughlinite, pyrite, and quartz. It also occurs there in gray shale with abundant shortite and northupite, some searlesite and loughlinite, in a fine-grained matrix consisting essentially of quartz and pyrite.

Norsethite occurs as clear to milky-white circular plates or flattened rhombohedral crystals, 0.2-2.0 mm. across. The mineral is insoluble in water but is readily decomposed by cold dilute hydrochloric acid. Norsethite has hardness about 3.5; density  $3.837 \pm 0.005$  (meas.), 3.840 (calc.); luster vitreous to pearly; fracture hackly; good rhombohedral cleavage. It is infusible before the blowpipe. Norsethite is uniaxial negative, and the indices of refraction are  $\omega=1.694$  and  $\epsilon=1.519$ . X-ray crystallographic studies show that the crystals are rhombohedral and have the following characteristics: possible space groups,  $R\bar{3}m$ ,  $R\bar{3}m$ , or  $R32$ , the most probable being  $R32$  ( $D_3$ ), a subgroup of  $R\bar{3}c$ , the space group of calcite; hexagonal  $a=5.020 \pm 0.005 \text{ \AA}$ ,  $c=16.75 \pm 0.02$ ; rhombohedral  $a_{rh}=6.29 \pm 0.01 \text{ \AA}$ ,  $\alpha=47^\circ 02' \pm 05'$ ; volume  $365.6 \text{ \AA}^3$  (hex.); cell contents:  $3[\text{BaMg}(\text{CO}_3)_2]$ , in the hexagonal unit. Crystal forms observed are  $c\{1000\}$ ,  $a\{120\}$ ,  $m\{10\bar{1}0\}$ , and  $r\{10\bar{1}1\}$ . The strongest X-ray lines are:  $3.015 \text{ \AA}$  (100),  $3.860$  (35),  $2.656$  (35),  $2.512$  (35),  $2.104$  (35),  $1.931$  (35),  $1.864$  (35).

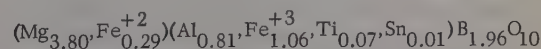
Norsethite has a structure similar to that of calcite. The structural relations of norsethite, dolomite, and calcite are discussed.

Chemical analysis of a 0.1 gm. sample gave: BaO 52.9, CaO 0.5, MgO 13.9, FeO 0.4, MnO 0.1,  $\text{CO}_2$  31.2,  $\text{Na}_2\text{O}$  0.2,  $\text{SiO}_2$  0.3, insoluble 0.4, total 99.9%.

Norsethite is named in honor of Mr. Keith Norseth, engineering geologist of the trona mine at Westvaco, Sweetwater County, Wyoming.--Auth.

**3-2690.** Schaller, Waldemar T., and Angelina C. Vlisidis. THE COMPOSITION OF THE ALUMINIAN LUDWIGITE FROM CRESTMORE, CALIFORNIA: *Am. Mineralogist*, v. 46, no. 3/4, p. 335-339, 2 tables, March-Apr. 1961, 9 refs.

The black crystals of the aluminian ludwigite (Woodford's mineral B) from the limestone at Crestmore, California, gave on analysis:  $\text{B}_2\text{O}_3=18.15$ ,  $\text{MgO}=40.67$ ,  $\text{FeO}=5.60$ ,  $\text{MnO}=0.02$ ,  $\text{Al}_2\text{O}_3=10.97$ ,  $\text{Fe}_2\text{O}_3=22.59$ ,  $\text{TiO}_2=1.50$ ,  $\text{SnO}_2=0.24$ ,  $\text{H}_2\text{O}=0.07$ ,  $\text{H}_2\text{O}+=0.05$ , insoluble=0.48; total=100.34%. Specific gravity 3.64. The formula is



or essentially  $\text{Mg}_2(\text{Fe}^{+3}, \text{Al})\text{BO}_3\text{O}_2$ . This ludwigite has the highest known content of  $\text{Al}_2\text{O}_3$  of any member of the ludwigite ( $\text{Mg} \gg \text{Fe}^{+2}$ )-vonsenite ( $\text{Fe}^{+2} \gg \text{Mg}$ ) series.--Auth.

3-2691. Wilkinson, J. F. G. SOME ASPECTS OF THE CALCIFEROUS AMPHIBOLES, OXYHORN-BLENDE, KAERSUTITE AND BARKEVIKITE: *Am. Mineralogist*, v. 46, no. 3/4, p. 340-354, 5 tables, March-Apr. 1961, 42 refs.

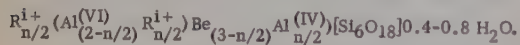
The brown calciferous amphiboles oxyhornblende, kaersutite, and barkevikite have been examined briefly in terms of their chemistry, optical properties, and mode of occurrence. The titaniferous amphibole kaersutite, generally considered to be a variety of oxyhornblende, often has low  $\text{Fe}_2\text{O}_3/\text{FeO}$  ratios and is therefore distinct from the latter mineral. Kaersutite and barkevikite compositions are dominated respectively by the end-member series pargasite-ferropargasite.

Optical properties of brown amphiboles assigned to the 3 species show considerable overlap. Birefringences greater than 0.040 characterize true oxyhornblendes.

Kaersutite and barkevikite are the brown calciferous amphiboles typically encountered in under-saturated alkaline rocks, barkevikite possessing higher  $\text{Fe}^{2+}/\text{Mg}$  ratios than kaersutite, and  $\text{Mg} < 2$  atoms. Kaersutite occurs most commonly in analcite-bearing rocks of wide compositional range and in nepheline-bearing basic rocks. On the other hand, barkevikite is more characteristic of the nepheline-syenites and is an Fe-enriched amphibole developed as a consequence of relatively less hydrous conditions resulting in increased  $\text{Fe}^{2+}/\text{Mg}$  ratios in the magma.--Auth.

3-2692. Beus, A. A. THE POSITION OF ALKALI METALS IN THE STRUCTURE OF BERYL: *Geokhimiya*, in translation, 1959, no. 3, p. 345-349, pub. 1960, 5 refs.

The position of the alkali metals in the atomic structure of beryl is discussed. Beryl is structurally similar to milarite. The expanded crystallochemical formula proposed for beryl is:



--L. M. Dane.

3-2693. Swineford, Ada, ed. CLAYS AND CLAY MINERALS. PROCEEDINGS OF THE EIGHTH NATIONAL CONFERENCE ON CLAYS AND CLAY MINERALS: 292 p., illus., maps, diags., graphs, tables, New York, Pergamon Press, 1960, refs.

The Eighth National Conference on Clays and Clay Minerals, sponsored by the Committee on Clay Minerals of the National Academy of Sciences-National Research Council, and the University of Oklahoma, was held at Norman, Oklahoma, Oct. 11-14, 1959. Members of the Oklahoma Geological Survey conducted a field trip to the Wichita Mountains on Oct. 11, for which the road log and field descriptions, by William E. Ham and others, are given, p. 1-10. In addition to papers of general interest on clay mineralogy and clay technology, the Proceedings stress clay-water systems and clay mineral-geochemical prospecting. The 19 complete papers in the Proceedings are separately abstracted below in the order in which they appear in the volume. Two papers appear as abstracts only: 1) Evaluation of the Amount and Distribution of Montmorillonite in Some Georgia and South Carolina Kaolins, by David N. Hinckley and Thomas F. Bates, p. 18-21; 2) Ion Adsorption on Clays: A Review, by H. van Olphen, p. 115.--A. C. Sangree.

3-2694. Murray, Haydn H., and S. C. Lyons. FURTHER CORRELATIONS OF KAOLINITE CRYSTALLINITY WITH CHEMICAL AND PHYSICAL PROPERTIES (In: Swineford, Ada, ed. *Clays and Clay Minerals*...: p. 11-17, 5 figs., 5 pls., New York, Pergamon Press, 1960) 8 refs.

Previous work has demonstrated that the degree of crystal perfection in kaolinite can be correlated with many physical properties. In this paper some further relationships are shown, including surface area, base exchange capacity, total percentage of Fe and Ti, and high-temperature mullitization. Surface area, base exchange capacity, and the total amount of Fe and Ti in the clay increase as the degree of crystal perfection decreases.--Auth.

3-2695. Beck, Carl Wellington, and George D. Brunton. X-RAY AND INFRARED DATA ON HECTORITE-GUANIDINES AND MONTMORILLONITE-GUANIDINES (In: Swineford, Ada, ed. *Clays and Clay Minerals*...: p. 22-38, 10 figs., 2 tables, New York, Pergamon Press, 1960) 23 refs.

Clay-organic complexes of the clay minerals sodium hectorite and sodium montmorillonite with the hydrochlorides of guanidine, amino-guanidine, methylguanidine, and triaminoguanidine were examined for thermal stability by the oscillating-heating X-ray technique. Completely exchanged complexes increase the thermal stability of these 2 clays by as much as  $275^\circ\text{C}$ .

Infrared analyses were also made on these same clay-organic complexes. There is a marked difference between the infrared patterns of the clay-organic complexes and the patterns of the clays or the organic salts alone. More experimental work must be done before it will be possible to interpret completely the clay-organic infrared patterns.--Auth.

3-2696. Bronson, Roy D., and others. POTASSIUM-DEPLETED MUSCOVITE. PART I. PREPARATION USING FILTRATION PROCESS FOR TREATMENT WITH MOLTEN LITHIUM NITRATE (In: Swineford, Ada, ed. *Clays and Clay Minerals*...: p. 39-43, 3 figs., New York, Pergamon Press, 1960) 6 refs.

The reaction between molten lithium nitrate and muscovite does not go to completion in a single treatment because of the equilibrium restriction imposed by the presence of K in the melt. An apparatus consisting of a stainless steel vessel with a porous stainless steel filter, valve and vacuum connections was designed to eliminate this restriction and to provide for more complete removal of the equilibrium melt in each successive treatment.

Macroscopic swelling of the muscovite in the molten lithium nitrate was observed after prolonged treatment. X-ray diffraction examination of samples of solidified melt revealed intracrystalline swelling in the muscovite.--Auth.

3-2697. Ponder, Herman, and Walter D. Keller. GEOLOGY, MINERALOGY, AND GENESIS OF SELECTED FIRECLAYS FROM LATAH COUNTY, IDAHO (In: Swineford, Ada, ed. *Clays and Clay Minerals*...: p. 44-62, 3 figs., pl., 5 tables, New York, Pergamon Press, 1960) 17 refs.

Fireclay deposits occur in Latah County, Idaho, as residual weathered products, and as lacustrine sediments comprising part of the Miocene Latah



formation. The residual deposits were developed upon granitic (granodioritic, gneissic) masses by surface weathering. The lacustrine fireclays were derived dominantly from weathered residuum and to a minor extent from volcanic ash.

Mineral proportions in the residual clay are typically as follows: kaolin minerals, 65%; quartz, 20%; K-bearing micas, 12%; and montmorillonite-chlorite mixed-layer clay, trace.

The sedimentary fireclay deposits range widely in clay content, from some that are almost wholly kaolin to others containing as little clay as the residual material, or alternatively, to those meeting minimal requirements of fireclay. As the content of kaolin decreases in the deposits, there is a corresponding increase in content of quartz, K-bearing micas, and in the less abundant components orthoclase, mixed-layer illite-montmorillonite, and mixed-layer chlorite-montmorillonite.

In both the transported and residual clay bodies the kaolin minerals are, in order of decreasing abundance, halloysite, endellite, and fireclay mineral.

The lake deposits also contain seams of poorly crystallized kaolin that is inferred to have been derived from volcanic ash because 1) it contains minor quantities of tridymite, sanidine, and volcanic glass, and 2) it contains notably more endellite and allophane (amorphous and relatively soluble in NaOH) than is present in the other kaolin deposits. Endellite seemingly has developed in 2 separate geologic environments: as an alteration product of granodiorite gneiss by surface weathering and as an alteration product of volcanic ash deposited and altered in a fresh-water lake. It is postulated that endellite is a relatively common product of weathering.--Auth.

**3-2698.** Glenn, R. C., and others. **CHEMICAL WEATHERING OF LAYER SILICATE CLAYS IN LOESS-DERIVED TAMA SILT LOAM OF SOUTHWESTERN WISCONSIN** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p. 63-83, 5 figs., 7 tables, New York, Pergamon Press, 1960) 25 refs.

Chemical weathering of layer silicate clay minerals in the major horizons of the Tama silt loam Prairie soil profile was followed down to 10 ft., where the calcareous parent loess was encountered, and on down to a depth of 13 ft. The predominant constituents of the clay fraction ( $-2\mu$ ) at all depths in the soil profile were montmorillonite (42%) and illite (20%), although vermiculite (12%), kaolinite (5%), and amorphous material (15%) were also in fair abundance. Deposition of secondary interlayer alumina was appreciable in the uppermost soil horizons but became less in amount in the deeper soil horizons. Quartz was not found in the clay fractions of less than  $0.2\mu$  in diameter at any depth in the soil profile, although both quartz and feldspars occurred in the coarse clay.

Vermiculite decreased from about 18% in the coarse clay and 5% in the fine clay of the deeper calcareous horizons to small amounts toward the soil surface, disappearing altogether in the fine clay ( $-0.08\mu$ ). Little variation was found in the montmorillonite percentage of the clay in the subsoil and lower horizons (64 to 75% of the fine clay), but a decrease in the 18 Å diffraction intensity of montmorillonite concurrent with an increase in amorphous silica and alumina (15 to 27% of the fine clay) was observed in the upper, acid, soil horizons, suggesting that montmorillonite is not a stable weathering product in the latter. Elemental analyses of the fine clays showed about 1.1 out of 4 octahedral positions to be Fe, 2.5

to be Al, and 0.4 to be Mg. A slight decrease in Fe and increase in Al in the montmorillonite octahedral structure occurred progressively in approaching the more intensely weathered zones near the soil surface.

The results suggest that dioctahedral montmorillonite has formed to considerable extent in both the calcareous and noncalcareous horizons by chemical weathering of trioctahedral ferromagnesian mica, through a vermiculite intermediate stage. The decrease in amount of the silt fractions of density greater than 2.66 g./cm.<sup>3</sup> (found to be composed mainly of biotite, chlorite, and amphiboles) in going from the calcareous horizons toward the soil surface approximately equalled the increase in montmorillonite percentage of the soil, suggesting that montmorillonite of the loess originated by chemical weathering of the ferromagnesian minerals of the silt. The genesis of the loessial montmorillonite begins long before the free CaCO<sub>3</sub> has been leached out (6% montmorillonite in the loess at 13 ft.) and continues to a maximum (14%) in the B horizon. Some eluviation of montmorillonite from the A horizon into the B horizon was evident.--Auth.

**3-2699.** Barshad, Isaac. **THERMODYNAMICS OF WATER ADSORPTION AND DESORPTION ON MONTMORILLONITE** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p. 84-101, 17 figs., New York, Pergamon Press, 1960) 5 refs.

Methods are presented for determining partial and integral thermodynamic quantities for the change in state of water and clay during the course of their interaction. The quantities determined are: free energy, heat, and entropy changes. The effect on the magnitude of these quantities of the nature and amount of the exchangeable cations is reported. It is concluded that the magnitude of change in the thermodynamic quantities due to moving the exchangeable cations out of the hexagonal cavities in the O sheets is considerably greater than that due to the parting of the O sheets during the interlayer expansion.--Auth.

**3-2700.** Martin, R. Torrence. **WATER VAPOR SORPTION ON KAOLINITE: ENTROPY OF ADSORPTION** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p. 102-114, 3 figs., table, New York, Pergamon Press, 1960) 19 refs.

Water vapor adsorption isotherms at 5 temperatures between 0 and 40°C. were obtained on Li and Na kaolinite. By a careful experimental technique, the error in the determination of weight of water adsorbed was reduced to  $\pm 0.01$  mg./g. and that of equilibrium vapor pressure was reduced to  $\pm 0.0002$  mm. Hg. The data were used to calculate the integral and differential entropy of the adsorbed water phase.

The differential entropy of adsorption (the partial molar entropy of water in the sorbate phase minus the molar entropy of normal liquid water) has large positive values at low surface coverage. As more water is adsorbed, the differential entropy drops to a negative value approximately equal to that of a 2-dimensional liquid which is about the same as the entropy for hypothetical ice at this temperature and pressure. The water can hardly be treated as "ice" because the large negative entropy persists over a very small  $p/p_0$  range and occurs at a  $p/p_0$  such that the surface is only about 70% covered. The integral entropy of adsorption (the molar entropy of water in the sorbate phase minus the molar entropy

of normal liquid water) has positive values on both Li and Na kaolinite throughout the  $p/p_0$  range investigated;  $p/p_0 = 0$  to  $p/p_0 = 0.5$ . These entropy data indicate that the water molecules in the adsorbed phase on Li or Na kaolinite possess greater randomness than the water molecules in normal liquid water from the dry clay up to at least  $p/p_0 = 0.5$ . The difference between integral and differential entropies is explained as a "configurational entropy" that changes with the amount of the adsorbed phase.

A hypothesis to explain the entropy data is proposed in which one builds inward from normal liquid water to the solid surface rather than the more conventional mechanisms which build outward from the solid surface. In this way the entropy data can be explained in terms of what happens to the structure of normal liquid water when different sized ions or nonpolar molecules, or both, are added. Literature data for the low density and dielectric coefficient of the sorbed phase plus the large amounts of unfrozen water still present at  $-50^\circ\text{C}$ . are frequently used as evidence for the quasi-solid structure of the sorbed phase. A consideration of the water molecules in the sorbed phase as more random than normal liquid water is an equally plausible explanation. Nuclear magnetic resonance and magnetic susceptibility data which cannot be explained by an increase in water structure are in complete agreement with the entropy data and the proposed new working hypothesis. It is concluded that not only the present entropy data but also all literature data (known to the author) concerning the sorbed phase can be satisfactorily explained if one considers the water molecules in the sorbed phase as being more random, less structured, than normal liquid water.--Auth.

3-2701. Frysinger, Galen Royer. CATION EXCHANGE BEHAVIOR OF VERMICULITE-BIOTITE MIXTURES (In: Swineford, Ada, ed. *Clays and Clay Minerals*...; p. 118-121, 2 tables, New York, Pergamon Press, 1960) 7 refs.

The cation exchange capacity of a series of commercially available vermiculite-biotite minerals (Traveler's Rest, South Carolina; Libby, Montana; and Polobora, South Africa) was measured by a column method using various cations. The selectivity of the clay mineral for various ion pairs was determined with particular attention given to the adsorption from a sodium chloride-cesium chloride mixed electrolyte solution. The mineral was found to be highly selective for Cs ion, a large part of the amount adsorbed probably replacing K ions in the biotite layers. This replacement in the biotite is a much slower process than normal ion exchange and greatly lengthened the time required to come to equilibrium in the column.

The Cs ion cannot be removed easily from Cs-saturated vermiculite. The fixation of Cs ion was close to 100% at room temperature in contact with a cesium chloride solution. An isotopic exchange, Cs 133 for Cs 134, removed only very small quantities of the fixed Cs. Boiling with sodium chloride was only slightly more effective. All the results are in general agreement with the theory explaining ion fixation on the basis of collapse of the vermiculite structure to that of biotite.--Auth.

3-2702. Bernstein, Fabian. DISTRIBUTION OF WATER AND ELECTROLYTE BETWEEN HOMOIONIC CLAYS AND SATURATING NaCl SOLUTIONS (In: Swineford, Ada, ed. *Clays and Clay Minerals*...;

p. 122-149, 19 figs., 4 tables, New York, Pergamon Press, 1960) 12 refs.

Ion and water uptake from solution by the Na and H forms of montmorillonite and illite were measured. The clays first were converted to homoionic form by treatment with synthetic ion exchange resins. The H clays were used to determine the acid strength of the exchange groups by titration with sodium hydroxide solutions. The Na clays were used to obtain the ion and water distribution. After attainment of equilibrium with sodium chloride solutions, the Na clays were centrifuged to constant weight and the equilibrating solutions analyzed for NaCl. Ion and water uptake and fixed charge concentration in the clays were then measured.

The clay minerals were found to behave as weak acids and the exchange sites are not appreciably dissociated until the pH of the external solution becomes moderately high. In the sodium form, the exchange sites are fully dissociated and the clays, particularly montmorillonite, become efficient Donnan membranes. The partially neutralized clays exhibit intermediate membrane behavior.

At low external phase salinities, the leakage of anions into the clay solution phase is abnormally large, but the membrane activity remains high because of the low activity coefficients of the diffusible ions in the clay phase. At high external solution salinities, the deswelling of the clays and the decrease in the anion to cation mobility ratio partially compensate for the increased anion leakage.

The abnormally low activities of the diffusible ions are directly related to the effect of the internal phase double layer. The concept of ion retardation in the double layer is used to explain the fact that ion transference numbers computed from internal phase ion concentrations are lower than experimental transference numbers.

The relationship of the electrochemical properties of clays to oil-well log interpretation is briefly discussed.--Auth.

3-2703. Granquist, W. T., and Sidney S. Pollack. A STUDY OF THE SYNTHESIS [SIC] OF HECTORITE (In: Swineford, Ada, ed. *Clays and Clay Minerals*...; p. 150-169, 9 figs., pl., 8 tables, New York, Pergamon Press, 1960) 10 refs.

Hectorite, a trioctahedral Mg montmorillonite, has been synthesized at atmospheric pressure and reflux temperature. The reaction mixture was the system  $\text{SiO}_2/\text{MgO}/\text{Li}_2\text{O}$  (or  $\text{LiF}$ )/ $\text{Na}_2\text{O}$  in a large excess of water. The starting ratios were based on the following formula for the mineral  $[(\text{Li}_x\text{Mg}_{6-x})\text{Si}_8\text{O}_{20}(\text{OH})_4]^{x-}\cdot x\text{Na}^+$ .  $\text{Li}^+$  has been found to accelerate the crystallization, and reasons for this effect are considered. Lowering of the pH of the reaction mixture by the use of alkali metal fluorides rather than hydroxides, resulting in an increase in the solubility of  $\text{Mg}(\text{OH})_2$ , also caused the crystallization of hectorite to proceed more rapidly. The products containing  $\text{Li}^+$  and  $\text{F}^-$  proxying for  $\text{Mg}^{2+}$  and  $\text{OH}^-$ , respectively, were found to be most like natural hectorite.

The time-dependent data obtained in this work were rationalized on the basis of a postulated appearance of hectorite embryos in the dilute aqueous solution of  $\text{Mg}^{2+}$ ,  $\text{OH}^-$  and  $\text{SiO}_2$ , followed by growth of this material to crystalline hectorite by transfer of components from solution to the solid phase.

Strese and Hofmann also conducted synthesis work in this area. A comparison of the products resulting



from the 2 techniques showed the main difference to be the presence of 001 spacings in the current product. These earlier workers made a point of the lack of 001 reflections.--Auth.

3-2704. Low, Philip F. VISCOSITY OF WATER IN CLAY SYSTEMS (In: Swineford, Ada, ed. *Clays and Clay Minerals...*: p.170-182, 8 figs., table, New York, Pergamon Press, 1960) 22 refs.

A method was devised for obtaining the activation energy for the viscous flow of a fluid through a porous medium, and the method was applied to the flow of water through samples of Na-bentonite. The resulting activation energies were generally higher than the activation energy for the flow of pure water. The activation energy depended on the length of time the water was in contact with the clay and also on the particular sample. For any given sample, the water flow rate was negatively correlated with the activation energy, in accordance with theory.

To help interpret these results, data are presented on the tension of water in Na-bentonite suspensions at different intervals of time after stirring. The water tension was near zero immediately after stirring but increased gradually with time. Simultaneously the suspension gelled. Data also are presented on the specific volumes of water, the activation energies for ion movement, the diffusion coefficients of chloride salts and the unfrozen water at -50°C. in Li-, Na-, and K-bentonite. The activation energies for ion movement and the amounts of unfrozen water were positively correlated with the specific volumes of the water, whereas the diffusion coefficients of the chloride salts were negatively correlated with the specific volumes of the water. In each clay the specific volume of the water and the activation energy for ion movement were higher than those in normal water.

It is concluded that a water structure, which varies in extent with particle arrangement and the adsorbed cationic species, exists at the surface of clay particles. This structure bestows a high viscosity to the adsorbed water.--Auth.

3-2705. Jonas, Edward C., and George L. Thomas. HYDRATION PROPERTIES OF POTASSIUM DEFICIENT CLAY MICAS (In: Swineford, Ada, ed. *Clays and Clay Minerals...*: p.183-192, 3 figs., New York, Pergamon Press, 1960) 6 refs.

A clay mineral that in its natural state expands to 15 Å with water and to 17 Å with ethylene glycol was treated with various concentrations of KCl. At the highest KCl concentration all the material was rendered nonexpanding. There was a threshold KCl concentration at which K ions were absorbed in sufficient quantities to prevent expansion of the clay in water. At concentrations less than the threshold the material is characterized by a random interlayer mixture of expanding and nonexpanding layers. The sequence produced with increasing KCl concentration is: expanding clay → interlayer mixture → nonexpanding clay.

Solvation with ethylene glycol is more effective than solvation with water for much higher K ion population densities in the interlayer space. At K ion population densities intermediate between those at the concentration thresholds for water solvation and for ethylene glycol solvation, there are layers that will expand with glycol and not with water.

Low K ion population densities correspond to low surface charge densities of K saturated clays, and

the clays expand like montmorillonite. The high K ion population densities correspond to high surface charge densities of K-saturated clays and illite and the clays do not expand. With intermediate K ion population densities corresponding to intermediate surface charge densities for K-saturated clays, the clays expand with ethylene glycol but not with water.--Auth.

3-2706. Lovering, T.S., and Anna O. Shepard. HYDROTHERMAL ARGILLIC ALTERATION ON THE HELEN CLAIM, EAST TINTIC DISTRICT, UTAH (In: Swineford, Ada, ed. *Clays and Clay Minerals...*: p.193-202, fig., 3 tables, New York, Pergamon Press, 1960) 5 refs.

On the Helen claim in Homansville Canyon, E. Tintic district, a small deposit of kaolinic clay typical of argillic alteration, together with hematite and Mn, occurs at the intersection of a minor N-S. fissure with a steep E.-trending contact of Tertiary quartz latite lava and dolomitized Cambrian Herkimer limestone. The fissure ends at a small, completely argillized monzonite plug about 100 yd. N.

Argillic alteration and other types of hydrothermal alteration are common near the ore deposits and many of the intrusive bodies that are scattered through the roots of the Eocene volcanic field in which the E. Tintic and Tintic districts lie. In most areas of argillic alteration abundant pyrite or alunite and barite suggest that the alteration was caused largely or in part by S acids, but in the Helen claim these minerals are virtually lacking, and in contrast fluorite, hematite, and manganese and aluminum oxides are abundant.

A mineral zonation parallel to the lava-dolomite contact is conspicuous. The zones in the lava outward from the contact are: (L1) a silicic zone 1-5 in. wide with some kaolinic clays, mixed-layer clay and micaceous minerals; (L2) a strongly argillized zone about 3 ft. wide having much montmorillonite and a moderate amount of kaolinic and micaceous minerals, but in which the kaolinic minerals decrease away from zone L1; (L3) transition zone 2-5 ft. wide in which montmorillonite diminishes, micaceous minerals increase, and kaolinic minerals disappear as altered rock grades into normal country rock. The bulk density of the rock decreases with the intensity of argillic alteration, and nearly all chemical constituents decrease in amount per unit volume; Mg, water, Mn, and F, however, increase conspicuously.

The zones in the altered dolomite away from the lava contact are (D1) a hematite-quartz zone 5-8 ft. wide, which contains some minor sericite and manganese oxides; (D2) a manganiferous zone 1-2 ft. thick containing abundant manganese oxides and hematite, and minor clay, quartz, and kaolinic minerals; (D3) a discontinuous zone about 8 in. thick of halloysite and kaolinite; (D4) a fluorite-kaolin zone with minor diaspore about 1 ft. thick; (D5) a diaspore fluorite zone about 4 1/2 ft. wide in which the kaolin minerals diminish away from zone D4; (D6) a diaspore-kaolinite zone about 1 ft. wide with minor fluorite and mixed-layer clays; (D7) a kaolin and mixed-layer clay zone about 3 in. thick with very minor manganese oxide, fluorite, and diaspore; (D8) a "sanded dolomite" zone about 10 ft. wide, consisting chiefly of weakly bonded granular dolomite with some kaolinite and mica; (D9) hard fresh hydrothermal dolomite extending outward for several hundred feet. Zone D8 grades imperceptibly into D9.

The mineral zones suggest reaction of dolomite with hot halogen-rich acid emanations carrying

halides of Fe, Al, and Si; the precipitation of the oxides of Fe, Mn, Si, and Al, and of fluorite, is appropriate to zonation responsive to the increasing pH caused by reaction with the carbonate wall rock. --Auth.

**3-2707.** Frederickson, A. F., and R. C. Reynolds, Jr. **GEOCHEMICAL METHOD FOR DETERMINING PALEOSALINITY** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p.203-213, 5 figs., 2 tables, New York, Pergamon Press, 1960) 6 refs.

The B content of sea water increases linearly with salinity within the range tested. The B content of the illite minerals in the clay mineral size fraction of many types of sedimentary rocks has been shown to increase with the "geologically known" salinity prevailing during deposition of the rocks. It is believed that B is abstracted by the illitic clay minerals from sea water in proportion to the salinity of the sea water. This B content is not substantially changed by other geological processes normally operative in sedimentary rocks. It is concluded that the B content of illite minerals in sedimentary rocks can be used to evaluate the salinity of the sea prevailing at the time the sediment was deposited. --Auth.

**3-2708.** Weaver, Charles E. **POSSIBLE USES OF CLAY MINERALS IN THE SEARCH FOR OIL** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p. 214-227, 5 figs., 2 tables, New York, Pergamon Press, 1960) 12 refs.

Most of our general knowledge concerning the distribution and geologic significance of clay minerals is summarized in 12 statements. Some examples and numerous suggestions are given to show the use of clay minerals in interpreting and understanding such problems as tectonics, source, age, boundaries, facies, environments, zonation, correlation, and metamorphism; a relation between the relative abundance of expanded clays and the occurrence of hydrocarbons is suggested.

It is believed that expanded clays retain their pore water to greater depths of burial than do other clays, and that it is this water which transports much of the hydrocarbon. It is shown that whereas time has little effect on the contraction of expanded clays, it does affect the expulsion of pore water from shales. --Auth.

**3-2709.** Grim, Ralph E., and others. **A MIXED-LAYER CLAY MINERAL ASSOCIATED WITH AN EVAPORITE** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p.228-236, 4 figs., 2 tables, New York, Pergamon Press, 1960) 4 refs.

Clay partings in the ore beds in a New Mexico evaporite section include a range of mixed-layer clay mineral sequences of the corrensite type. Specimens range from nearly regular alternations to sequences which depart from regularity to moderate degrees. The ore bodies consist of halite, polyhalite, sylvite, magnesite, dolomite, carnallite, and iron oxides.

Observed X-ray diffraction effects from representative specimens are compared with synthesized effects for montmorillonite- or vermiculite-chlorite layer sequences.

It is concluded that the segregation of the abundant Mg interlayer content into specific, regularly spaced interlayers represents the equilibrium relationship between a montmorillonite-chlorite or vermiculite-

chlorite mixed assemblage and a mildly acid,  $Mg^{2+}$ ,  $Na^{+}$ , and  $K^{+}$ -rich environment. --Auth.

**3-2710.** Dodd, Charles G., and Satyabrata Ray. **SEMIQUINONE CATION ADSORPTION ON MONTMORILLONITE AS A FUNCTION OF SURFACE ACIDITY** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p. 237-251, 3 figs., 5 tables, New York, Pergamon Press, 1960) 14 refs.

Semiquinone cations derived from aromatic diamines by one-electron oxidation in aqueous solution possess characteristic colors that depend on H ion concentration. The colored free radicals are formed by oxidation on the surface of certain montmorillonite clay minerals, where they are stabilized by adsorption, apparently in cation exchange positions, but many clays react anomalously when the procedure is employed as a diagnostic test for montmorillonite. One of the problems involved is the chemical nature of the various semiquinones. Another is the effect of clay mineral crystal structure on the color that is produced.

The dihydrochlorides of benzidine, p-phenylenediamine, and N, N-dimethyl-p-phenylenediamine in aqueous solution have been used with a centrifuged Wyoming bentonite (montmorillonite) and a centrifuged hectorite clay, each suspended in various buffered solutions, to study the pH effect and the quantity and nature of the semiquinones formed. Hypothetical structures differing by 1 H (or hydronium) ion have been assumed for 2 semiquinone forms of each diamine, each formula representing a distinct hue, with the divalent cation formed at low pH and the monovalent cation at a higher pH. Mixtures of the 2 cations were assumed to exist at intermediate acidities corresponding to mixtures of the 2 hues. A simple set of equations was postulated to describe these reactions, and the theory was tested experimentally by determining the amount of N adsorbed on each clay sample at a series of fixed pH values ranging from 0.5 to 6.5.

The milligram atoms (mga) of N (or 2 x millimoles of diamine) adsorbed were found to increase with increasing pH in approximately the amount predicted in the range 1.0-4.2. In this pH range, however, the calculated base exchange capacity (BEC) for each clay was lower than the accepted value, presumably because an approximately constant fraction of the base exchange sites was occupied by nonexchangeable cations, probably Al and H ions. Amounts of base adsorbed were the same whether Na or Ca ions were initially in exchange positions. At pH values of 5.5 and 6.5 the mga of N adsorbed showed a sharp increase, apparently because colloiddally dispersed reagent diamine was formed as the free base and no Al or hydronium cations were adsorbed. When corrections were made for nonadsorbed free base (not adsorbed on exchange positions but physically adsorbed to the floccules) and, in the case of benzidine, for base lost in filtration, the calculated BEC's for each clay were in satisfactory agreement with accepted values. --Auth.

**3-2711.** Oakes, David T. **SOLIDS CONCENTRATION EFFECTS IN BENTONITE DRILLING FLUIDS** (In: Swineford, Ada, ed. *Clays and Clay Minerals*. . . : p.252-273, 11 figs., 3 tables, New York, Pergamon Press, 1960) 17 refs.

A series of studies of the apparent electrokinetic potential and other characteristics of aqueous bentonite systems as they are affected by bentonite



concentration is presented. A new concentration parameter, which logically arises from a previously presented filtration theory is demonstrated to describe adequately the effects of solids concentration. The concentration parameter is analytically derived and is shown to make suitable allowance for the absorbed phase on the bentonite particles.--Auth.

3-2712. Dixon, J. B., and M. L. Jackson. MINERALOGICAL ANALYSIS OF SOIL CLAYS INVOLVING VERMICULITE-CHLORITE-KAOLINITE DIFFERENTIATION (In: Swineford, Ada, ed. *Clays and Clay Minerals*...: p. 274-286, 2 figs., 3 tables, New York, Pergamon Press, 1960) 24 refs.

The content of kaolinite plus halloysite is differentiated quantitatively from chlorite by differential dissolution, even in those samples wherein each mineral has 500°C. heat instability of the 7 Å peak. This differentiation is possible because the structures of kaolinite and halloysite are destroyed on loss of the 7 Å peak, producing amorphous material which is rapidly soluble in 0.5 N NaOH, whereas the chlorite structure remains largely intact with only partial dehydration of the octahedral layer. The amorphous residue of kaolinite-halloysite is dissolved from the other mineral components of the heated sample with sodium hydroxide and the dissolved silica and alumina are allocated to kaolinite. The percentages of kaolinite thus obtained for Elliott, B<sub>3</sub>-C horizon, 2-0.2 $\mu$  fraction, are 3.8 and 3.7 based on silica and alumina, respectively. Similarly, the percentages of kaolinite obtained for Buchanan, B<sub>1</sub> horizon, 2-0.2 $\mu$  fraction, are 14.9 and 13.8 based on silica and alumina, respectively. Collapse of the vermiculite basal spacing to 10 Å on K saturation and heating to 300°C., together with the clear differentiation of kaolinite by differential dissolution analysis (D.D.A.) above, removed the possibility of misinterpretation of the chlorite-like diffractometer tracing by kaolinite and vermiculite occurring together. Other clays, from Davidson and Susquehanna soils, had 44 and 42 to 43% kaolinite, based on silica and alumina, respectively. The vermiculite and montmorillonite contents of soil clay samples are quantitatively determined by specific surface. The mica percentages are based on the K<sub>2</sub>O after exclusion of K in feldspars. Water loss in the 400°C.-to-ignition range gives an important quantitative basis for chlorite.--Auth.

3-2713. Konta, J. IMBIBOMETRY - A NEW METHOD FOR THE INVESTIGATION OF CLAYS: *Am. Mineralogist*, v. 46, no. 3/4, p. 289-303, 8 figs., 3 tables, March-Apr. 1961, 6 refs.

A method for rapid identification of clay minerals in natural clays or in artificial aggregates prepared by elutriation and sedimentation of clay particles is described. The behavior of a drop of water and a drop of ethylene glycol on the surface of a smoothed section is observed. The section is easily prepared on glass- and emery-cloth. The following physical properties are decisive: 1) total surface area of the particles, 2) marked swelling of montmorillonite and "open" illite and no swelling of kaolinite and "closed" illite, 3) small wettability of aggregates of the kaolinite group minerals and greater wettability of illite and montmorillonite aggregates. The speed of imbibition of the liquid by the clay aggregate is regulated by the absorption equation. The method is explained on the basis of the experimental data, obtained by the investigation of 11 clays from Central Europe.--Auth.

3-2714. Cole, W. F., and Norma M. Rowland. AN ABNORMAL EFFECT IN DIFFERENTIAL THERMAL ANALYSIS OF CLAY MINERALS: *Am. Mineralogist*, v. 46, no. 3/4, p. 304-312, 4 figs., March-Apr. 1961, 10 refs.

If in differential thermal analysis the differential thermocouple is arranged radially through the center of an uncovered cylindrical sample holder, a spurious endothermic effect can be produced in the low-temperature region of curves of vermiculite (and of montmorillonite) when the amount of sample is reduced below a certain limit. No such peak occurs when the sample is covered with a lid or when the differential thermocouple is arranged along the axis of the sample holder with its bead at the center. The origin of the peak is investigated and it is shown how this depends on the experimental conditions and the clay mineral structure.--Auth.

3-2715. Lodding, William. GIBBSITE VERMIFORMS IN THE PENSAUKEN FORMATION OF NEW JERSEY: *Am. Mineralogist*, v. 46, no. 3/4, p. 394-401, 3 figs., table, March-Apr. 1961, 12 refs.

Vermiform aggregates found in 7 localities in the coarse sands of the Pensauken formation [Pleistocene] were identified as composed mostly of gibbsite. Although their appearance is very similar to kaolinite vermiforms and knauei described in the literature, all indications are that they are authigenic and formed by direct weathering of feldspar and other silicates to gibbsite, suggesting a near-laterite type of weathering during an interglacial period of the Pleistocene in this area.--Auth.

3-2716. Droste, John B. CLAY MINERAL COMPOSITION OF SEDIMENTS IN SOME DESERT LAKES IN NEVADA, CALIFORNIA, AND OREGON: *Science*, v. 133, no. 3468, p. 1928, table, June 16, 1961, ref.

X-ray analyses of some Recent desert lacustrine sediments in Nevada, California, and Oregon show that illite and montmorillonite are the most abundant clay minerals and that chlorite and kaolinite are present in subordinate amounts in the sediments of many of the lakes. These clay suites are derived from source rocks.--Auth.

3-2717. Hower, John. SOME FACTORS CONCERNING THE NATURE AND ORIGIN OF GLAUCONITE: *Am. Mineralogist*, v. 46, no. 3/4, p. 313-334, 8 figs., 6 tables, March-Apr. 1961, 23 refs.

The compositional variations of glauconite can be related to differences in mixed-layering involving "illite" (10 Å) and "montmorillonite" (expandable) layers. The interlayer cations K and Rb and the octahedral cation Fe decrease with increasing amounts of expandable layers. Sr increases rapidly with increasing percent expandable layers and because it is largely exchangeable is assumed to be present in the expandable layers as an exchange ion.

The relationships between structure and composition are used to examine Burst's model for glauconitization. Pellets that occur in clean sandstones, limestones and dolomites are almost exclusively monomineralic, consisting only of mixed-layer illite/montmorillonite with a low percent expandable layers. Pellets that occur in argillaceous sandstones and marls frequently contain extraneous clay minerals, and the illite/montmorillonite con-

tains a high percent expandable layers. Because of the well known observation that glauconite forms only at relatively low sedimentation rates it is concluded that the pellets occurring in argillaceous sandstones and marls represent less glauconitized material than those pellets occurring in clean sandstones, limestones, and dolomites. These observations fit Burst's model for glauconitization which assumes a degraded 2:1 layer-lattice structure as the parent material and the glauconitization process as a gradual substitution of Fe for Al in the octahedral positions, a concomitant gradual increase in lattice charge (arising from the octahedral layer) and a consequent increase in interlayer K which results in the collapse of increasingly more layers to the nonexpandable 10 Å type. It is also shown that K increases with octahedral charge and is independent of tetrahedral charge, a phenomenon predictable from Burst's model but no other.

Glauconites differ significantly in composition and structure with geologic age. Young glauconites are lower in K (and thus higher in percent expandable layers) and are more frequently mineralogically heterogeneous than older glauconites. A large part of these age differences appears to be explainable on the basis of lithologic association. However, there is some evidence for late epigenetic gain of K.

Weaver has shown similar differences with geologic age in the clay mineral assemblages of shales. Because of this similarity and because a good case can be made for attributing most of the variations in the mineralogy of glauconite pellets to diagenetic effects, it is suggested that diagenesis may have played an important role in the formation of the clay mineral assemblages of shales.--Auth.

**3-2718. Webster, Robert. FLUORESCENCE IN GEMSTONE IDENTIFICATION:** *Lapidary Jour.*, v. 14, no. 6, p. 492, 494-496, 500-509, illus., diags., Feb. 1961.

The history of investigations into photoluminescence is briefly discussed, followed by definition of terms and discussions of theories concerning causes of the phenomena. Ultraviolet portable sources are described and instructions given for use. Concise data on photoluminescent properties of selected gemstones are furnished. The following are treated: diamond, ruby, corundum, beryl, chrysoberyl, spinel, topaz, tourmaline, quartz, chalcedony, opal, zircon, orthoclase (moonstone), turquoise, jadeite, lapis lazuli, spodumene, fluorite, pearl, scapolite, scheelite, benitoite. The following do not fluoresce: aquamarine, garnet, peridot, nephrite.--J. Sinkankas.

**3-2719. Vierthaler, Arthur A. THERE ARE DIAMONDS IN WISCONSIN:** *Lapidary Jour.*, v. 15, no. 1, p. 18, 20, 22, 26, illus., map, Apr. 1961, 5 refs.

The history of diamond discoveries along southern edges of ancient glacier moraines in Wisconsin and contiguous areas of the Great Lakes region is briefly discussed along with the most important diamond crystals found. It is remarkable that all diamond crystals of consequence were found prior to 1904. Despite extensive subsequent geological investigations and drillings in the intervening years, no crystals have been found or reported since that year. A sketch map of the southern limits of glacier movement along with spots marking finds is included. Photographs of diamond crystals from the region clearly show the predominant dodecahedral crystal habit.--J. Sinkankas.

**3-2720. Burlison, Dan M. THE SHUNGNAK JADE PROJECT:** *Lapidary Jour.*, v. 15, no. 1, p. 10-13, illus., Apr. 1961.

The only known deposits of nephrite jade suitable for lapidary purposes occur in the Kobuk River drainage of NW. Alaska. Jade is mined regularly only from alluvial deposits at Jade Mountain, Shungnak River, and Dahl Creek. Difficulties and methods of access to the area are discussed along with quality and quantity of jade and probable reserves. The Indian Arts and Crafts Board of the U.S. Dept. of the Interior sponsors a project involving recovery and working of jade by Eskimos at Shungnak Village.--J. Sinkankas.

**3-2721. Borchert, Nal. A NEW STRIKE OF LAPIS LAZULI IN CALIFORNIA:** *Lapidary Jour.* v. 15, no. 1, p. 106, 107, illus., Apr. 1961.

Hundreds of pounds of lapis lazuli suitable for ornamental purposes have been recovered from a newly-discovered deposit in the North Fork of Cascade Canyon, San Bernardino Mountains. The locality is approximately 12 mi. N. of Upland on the NW. slope of Ontario Peak, about 1 1/2 mi. from Hogsback Mountain. Two veins containing masses of lapis lazuli have been exposed. The deposit is being worked under special-use permit from the U.S. Forestry Service. Another deposit of lapis lazuli in the North Fork of Cascade Canyon has been previously mined but produced little of commercial significance. Other important deposits are known in Chile, Peru, Siberia, and Afghanistan. The new material has been appraised at 50¢ per carat in polished form.--J. Sinkankas.

**3-2722. Murdoch, Joseph. CRESTMORE, PAST AND PRESENT:** *Am. Mineralogist*, v. 46, no. 3/4, p. 245-257, 4 figs., table, March-Apr. 1961, 18 refs.

Address of the retiring President of the Mineralogical Society of America at the 41st annual meeting of the Society, Denver, Colorado, Nov. 1, 1960.

The earliest activity at Crestmore, W. of Riverside, California, was the quarrying of limestone for lime-burning at some period before 1907. In 1927 a shaft was started for underground mining. Since 1946-1947 all production has been from underground workings which are down to a depth of about 550 ft. below the surface.

Oldest rocks are metasediments, in part crystalline, with some quartzite and other metamorphic types. These may be Mississippian or Triassic in age. These rocks have been extensively invaded by quartz diorite which represents the northerly extension of the San Diego batholithic complex. Erosion has lowered the surface so that only patches of the metamorphics have been preserved, embedded in a matrix of the quartz diorite as roof pendants or "curtains." The Crestmore area represents one of these patches, which consists mainly of crystalline limestones or marbles and a lesser amount of quartzite. Contact effects of the quartz diorite are expressed by the presence of a relatively narrow simple contact zone. Contact effects of the quartz monzonite porphyry are much more pronounced. The thick masses of contact rock show a zonal distribution of minerals from the intrusive contact to the untouched limestone, and it is in this region that many of the unusual minerals appear.

The total number of named and identified minerals to date is 137, with an additional dozen or so which



are unidentified. Of the named minerals, 9 are new; 5 of these have not been found elsewhere, and 2 more in only 1 or 2 other localities. A history of the discovery of these minerals is given. The presence of such a great variety of minerals is due to the rather complex geologic history of the occurrence, which started with the metamorphism of the original sediments, included the crystallization of the various igneous intrusions, continued with their successive contact effects, and ended with surface weathering and oxidation. The various groups of minerals are described.--A. C. Sangree.

3-2723. Johnson, Paul W. THE MINERAL COLLECTOR'S MEXICO: Gems & Minerals, no. 283, p. 18-21, 54-57; no. 284, p. 18-21, 49, 50, illus., 3 maps, 1961.

An informal narrative of collecting and sightseeing experiences in Mexico during which many localities were visited as well as museums and other institutions of interest to the earth scientist. Detailed instructions for reaching mines, quarries, and other points of interest are given along with names of helpful officials.--J. Sinkankas.

## 9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Structural Geology 3-2535; Geochemistry 3-2643, 3-2645, 3-2646, 3-2652, 3-2671, 3-2672; Sedimentary Petrology 3-2738.

3-2724. Belknap, William, Jr. MAN ON THE MOON IN IDAHO: Natl. Geog. Mag., v. 118, no. 4, p. 504-525, 21 illus. (19 col.), Oct. 1960.

Craters of the Moon National Monument, located in southern Idaho, is a 75 sq. mi. area of numerous extinct volcanic craters and lava flows concentrated in a rift zone at least 16 mi. long. The craters are grouped into cinder cones up to 760 ft. high and lava domes to 50 ft. in elevation. The lava fields are composed of both pahoehoe and aa types. Two ages of flows have been discerned, and a third and older one is suspected. Dendrochronologic dating suggests that the youngest of these flows occurred 1,600 years ago. Studies are presently underway to differentiate and classify the various flows.--H. G. Richards.

3-2725. Shashkina, V. P. MINERALOGY OF WEATHERED BASALT CRUST IN WEST VOLYNIA. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 5, p. 393-407, 13 figs., 4 tables, May 1961, 18 refs.

This article describes the weathered crust of extrusives of basic composition developed in W. Volynia. Four different weathered crust zones are distinguished on the basis of the degree of mechanical disintegration and hypergene alteration of the rocks. The article gives a petrographic and mineralogic description of the individual zones as well as an account of the principal minerals in the hypergene complex. The reasons are given for the disproportionate amount of various flows in the weathered crust. Genesis of the weathered crust as a whole is discussed, and also the processes which determine the nature of the individual zones. The zonation of the layered silicates (celadonite, mountain leather, chlorite, and minerals of the montmorillonite group, and halloysite) and other hypergene minerals is mainly determined by the pH value of the solutions. The weathered basalt crust of W. Volynia is a typical case of a crust formed over a long period on basic rocks in a warm and humid climate.--Auth.

3-2726. Dimitrov, Str. THE DEVELOPMENT OF MAGMATISM IN BULGARIA AND THE DISTRIBUTION OF THE ASSOCIATED ORE DEPOSITS: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 8, p. 1-7, fig., 2 tables, pub. 1961, 17 refs.

Bilibin's scheme, like those previously proposed, aids in making comparative studies of the development of magmatism, tectonics, and metallogeny in

the different mobile zones and different tectonomagmatic cycles. Such studies reveal general regularities and specific peculiarities which, to a greater or less degree, disturb the normal course of related processes.

As emphasized by Stille, the variations in the normal course of development arise, first of all, because during a geotectonic cycle a given phase of folding affects only one part of a geosyncline, which then passes into a quasicratonic state while adjacent parts still continue to subside. This changes simultaneously the type of magmatism and the region of its manifestation. Especially significant complications occur during the middle stages, i. e., at the time of the most intensive folding. A particularly clear illustration of this is the middle stage of the Alpine cycle, which included several phases of folding differing in extent and sometimes partially overlapping because of the gradual development of the folded zone. This fact determined the great variation in composition of the igneous rocks formed during this stage. Depending on the geological setting of their formation, they present the characteristics of deep-seated, very uniform, granite batholiths or of hypabyssal intrusives with strong Pacific type characteristics and a large range of differentiation, or as in the case of the Alpine cycle, the igneous rocks form small intrusions of extremely variable composition ranging from pyroxenites to very acid granites and syenites. Evidently in the case of a great variety of intrusive rocks, assimilation plays an important role, and it also influences the associated mineralization.

Similar complications occurred during the formation of the above-mentioned leucocratic granites of the initial stage of development of the Jurassic geosyncline and during the Upper Cretaceous andesite-trachyte volcanism coinciding with the geosynclinal regime in the Srednegorye structural belt. The explanation of these complications must be sought by profound analysis of the entire geological setting and of the composition of the corresponding magmatic complexes. The very fact that these problems arise helps further development of the proposed schemes and makes it easier to solve the problem of the general pattern of the development of magmatic activity, tectonics, and metallogeny in folded regions.--Auth. summ.

3-2727. Irvine, Thomas N. ULTRABASIC ROCKS IN THE LAC DES MILLE LACS AREA, MANITOBA [SIC]: Can. Mining Jour., v. 82, no. 4, p. 74-75, table, Apr. 1961, 8 refs.

Ultrabasic rocks near Quetico and Shebandowan in the Lac des Mille Lacs area NW. of Fort William,

Ontario, are compared with ultrabasic rocks in other parts of the world.

It is possible to subdivide Alpine ultrabasic rocks into 2 types. The "common" type occurs in the Appalachians, central British Columbia, California, and Oregon. A second type occurs in SE. Alaska and in the Ural mountains. Features of both types are enumerated. The Lac des Mille Lacs outcrops have certain features of both types.

Deposits of Ni-Cu sulfides, Cr, Pt, and Pd are associated with the 2 ultrabasic types and are found to some extent in the Lac des Mille Lacs rocks.--W. C. Peters.

**3-2728.** Pinus, G. V. **CHEMICAL AND GEOCHEMICAL CHARACTERISTICS OF THE CAMBRIAN EXTRUSIVES OF TUVA:** *Geokhimiya*, in translation, 1959, no. 1, p. 99-111, 3 figs., 6 tables, pub. 1960, 12 refs.

Chemically the Cambrian extrusives are of the calc-alkalic type. They are derivatives of basaltic magma and belong to the spilite-keratophyre suite extruded during the early stages of formation of the Caledonian Tuvan geosyncline.

As a result of differentiation of the basaltic magma, lavas were formed ranging in composition from basalts to albitophyres and rhyolites. This process however, did not follow the normal course of magmatic evolution entirely, and the general tendency of lavas to change in composition from mafic to felsic was complicated by alternation of lavas of varying degrees of maficity. This may be explained by the interrupted character of eruptive activity. After a period of dormancy in a local magmatic chamber, the products of advanced differentiation were erupted by a volcano first and were followed by more mafic lavas tapped by deeper volcanic vents.

The Cambrian extrusives of Tuva are characterized by a definite assemblage of trace elements which almost always contains the Fe group of elements and also Cu, Zn, Zr, Ga, Sr, and Ba. The regular variation in the trace element content during the process of magmatic differentiation is characteristic. In the course of normal magmatic evolution the content of the Fe group of elements and of Ga decreases, while the content of Zn, Sr, and Ba increases.

A comparison of the chemistry of the Devonian and Cambrian lavas of Tuva indicates that both were derived from basaltic magma. The composition of the Devonian lavas, however, reflects a more advanced stage of differentiation of the parent magma. This situation is quite natural because the level of mag-

matic activity during the initial stages of development of the Caledonian Tuvan geosyncline was much lower than that which could be reached by the middle Paleozoic Tuva downwarp superimposed on the folded Salair basement.--Auth. concl.

**3-2729.** Tsvirko, V. F. **XENOLITHS IN DIORITE PORPHYRY DIKES OF THE EASTERN UPPER YANA REGION:** *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 9, p. 81-82, pub., 1961.

Diorite porphyry dikes in the Dyby polymetallic area contain xenoliths of effusive and metamorphic rocks not found locally. A detailed description is given. The xenoliths give an indirect indication of the structure of the S. Verkhoyansk synclinorium.--M. Russell.

**3-2730.** Sviridov, V. V. **NEW DATA ON THE GRANITOIDS OF THE MAIN RANGE IN THE NORTHWESTERN CAUCASUS:** *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 8, p. 42-56, 2 figs., 5 tables, pub. 1961, 9 refs.

The author's investigations provide new material on the granitoids of part of the main range of western Caucasus and a more exact knowledge of the relationships between the lower Carboniferous deposits, the rocks of the ancient substratum, and the individual intrusions of the granitoid complex of the main range.

These investigations have shown that in the W., from the upper waters of the Malaya Laba river to the sources of the Kisha river, in the Perevalnaya subzone of the main range of western Caucasus, there are exposures of various, mainly plagioclase-rich granitoids containing dikes and amphibole gneisses belonging to the Urushtensky complex. The varieties of microcline granite of the Perevalnaya subzone, as well as the complex Verkhne-Urushtensky massif, were formed, apparently, synchronously in Hercynian time and are a part of the main range granitoid complex.--Auth. summ.

**3-2731.** Andreeva, E. D. **GABBROIC PEGMATITES IN SINYAYA MOUNTAIN PYROXENITE, THE MIDDLE URALS:** *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 9, p. 29-40, 5 figs., 2 tables, pub. 1961, 8 refs.

An unusual gabbroic pegmatite in basic and ultrabasic rocks of the Urals is described, with information on its geologic position, structural features, composition, and origin.--Auth.

## 10. SEDIMENTARY PETROLOGY

See also: Stratigraphy 3-2549, 3-2554; Geochemistry 3-2664, 3-2682; Mineralogy 3-2717.

**3-2732.** Pelletier, Bernard R. **THE MEASUREMENT OF GRAIN DIAMETERS IN THIN SECTION WITH THE USE OF A STRIP GAUGE:** *Carleton Univ., Dept. Geology, Geol. Paper 60-1*, 5 p., fig., 1960, 8 refs.

A strip gauge is described which can be applied directly to the magnified apparent grain diameters observed in camera-lucida or microprojector images of thin-sectioned specimens of sedimentary rocks being analyzed for grain-size determination.

The gauge consists of a narrow wedge-shaped strip of acetate upon which are drawn in descending order a series of progressively smaller circles or

gauges which mathematically and optically relate the observed apparent diameters to the chosen grain-size classification.--M. Russell.

**3-2733.** Tourtelot, Harry A. **THIN SECTIONS OF CLAY AND SHALE:** *Jour. Sed. Petrology*, v. 31, no. 1, p. 131-132, March 1961, 3 refs.

Clay and shale samples can be impregnated while retaining their natural moisture. Carbowax 6000 (Carbide and Carbon Chemical Co.), a waxlike high molecular weight polyethylene glycol compound was used. This wax is not isotropic and reacts with some clay minerals. After impregnation the samples can be cut and thinsectioned using kerosene instead of water. The kerosene is removed before the slice



is mounted on a glass slide. Samples required for sectioning should be collected moist in the field and well wrapped immediately in aluminum foil to prevent their drying out.--D. Carroll.

3-2734. Weber, Jon N., and F. Gordon Smith. RAPID DETERMINATION OF CALCITE-DOLOMITE RATIOS IN SEDIMENTARY ROCKS: Jour. Sed. Petrology, v. 31, no. 1, p.130-131, March 1961, ref.

An X-ray diffraction technique is described for determining calcite-dolomite ratios with a standard deviation of 1.3% and a detection limit of about 5%. Well-mixed powdered rock is mounted on a glass slide with thermo-setting plastic or Canada balsam and ground on a glass plate to produce a smooth surface. The slide is mounted in an X-ray diffractometer, and the pattern is recorded of the  $d$  spacings corresponding to  $29^{\circ}$  to  $31^{\circ} 2\theta$  using a scanning rate of  $1/8^{\circ}$  per minute. The intensity of the  $d$  spacings of calcite and dolomite are determined by summation of gamma counts over the curves, or by planimeter measurement of the area under the curves. Calibration curves are made of weight mixtures of calcite and dolomite, and unknown mixtures are compared. A plot of weight percent dolomite ( $y$ ) against  $\text{area}_{\text{dol.}} / \text{area}_{\text{cal.}}$  ( $x$ ) for a series of standards gave a linear relation:  $y = 95.3x + 5.52$ .--D. Carroll.

3-2735. Gabinet, M. P. DOLOMITE AND SIDERITE OF THE MENILITE SERIES IN THE SOVIET CARPATHIANS. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 5, p.385-392, 4 figs., 4 tables, May 1961, 5 refs.

The results of a mineralogic study of lenticular carbonate concretions in rocks of the menilite series [Oligocene] are presented in this paper. These concretions have been found to consist mainly of Fe dolomite with an admixture of pelitomorphous calcite. There is about 10 to 30% of argillaceous matter, finely dispersed organic matter, quartz grains, and other materials in the rocks. The siderite concretions occur only with silicified argillite and layers of chalcedony in the menilite series. About 30% of the iron oxide is replaced by Mg in the siderite, so that it can be called sideroplesite. The siderite concretions are silicified and contain chalcedony and pelitomorphous calcite inclusions. They were formed in the bituminous menilite rocks during early diagenesis in the stage of redistribution of sedimentary matter.--Auth.

3-2736. Young, L. M., and C. J. Mankin. DIMENSIONAL GRAIN-ORIENTATION STUDIES OF RECENT CANADIAN RIVER SANDS: Oklahoma Geology Notes, v. 21, no. 4, p.99-107, 4 figs., Apr. 1961, 22 refs.

Studies of fine sands in a fluvial environment reveal that preferred grain orientation exists in all types of channel deposits, ripple marks, and bar deposits. Study of the orientation of the petrographic  $c$ -axes of quartz grains in oriented thin sections also demonstrates that linear ripple marks have a dimensional grain orientation parallel with their trends, whereas the grain orientation in linguoid ripples is perpendicular to their trends. This difference in grain orientation is considered to be a function of mean current velocity.

On the basis of the complexities found in the orientation of grains in small-scale sedimentary structures, it is concluded that dimensional grain-

orientation analysis for paleotrend determinations, with particular reference to fluvial environments, is of dubious value.--C. J. Mankin.

3-2737. Teodorovich, G. I. ON THE ORIGIN OF SEDIMENTARY DOLOMITES. Translated by Ivan Mittin: Internat. Geology Rev., v. 3, no. 5, p.373-384, May 1961, 50 refs.

The author sets forth his ideas about the formation of dolomite rocks, according to prolonged mineralogical and petrographic investigations and in accordance with experimental physical and chemical data received by O. K. Yanateva. It is shown that formation of dolomites may take place in various ways and that means of dolomitization by replacement are diverse, it being known that phenomena of lime sediment replacement are predominant. Basic characteristics of primary chemical and of replacement dolomites belonging to the period of sediment diagenesis are established. Six principal cases of the formation of replacement dolomites after  $\text{CaCO}_3$  limes are distinguished. During the Precambrian and the Paleozoic,  $\text{CO}_2$  in the atmosphere was much higher than at present; according to the author this contributed to the broadness of the "field of dolomite formations" at that time. In most cases the increase in salinity to a certain limit favors the formation of dolomites equalizing the solubilities of dolomite and of calcite. This work contains also some criticism of N. M. Strakhov's ideas stated in an article entitled "Facts and Hypotheses in the Problem of Dolomite Rock Formations" [GeoScience Abstracts 1-221, 2-1784] as giving a fallacious interpretation of the principal questions raised. The relation of the overwhelming majority of fossil dolomites to seas and lagoons is shown in the article. The vast development in nature - particularly in Paleozoic sediments - of primary sulfate-dolomite and of dolomite-sulfate rocks, as well as the dolomite content of most anhydrite and gypsum confirms the ideas of the author about the frequent formation of dolomite in saline lagoons involving  $\text{MgCO}_3$ , not in cases however of high  $\text{MgCO}_3$  concentration in the solution.--Auth. English summ.

3-2738. Ross, Clarence S., and Robert L. Smith. ASH-FLOW TUFFS: THEIR ORIGIN, GEOLOGIC RELATIONS AND IDENTIFICATION: U.S. Geol. Survey, Prof. Paper 366, 81 p., 2 col. illus., 98 figs., 1961, 182 refs.

Pyroclastic materials, which are interpreted as having been deposited by flowage as a suspension of ash in volcanic gas, are becoming widely recognized as major geologic episodes. These may be unconsolidated, indurated by partial welding, or welded into a compact rock. Many students are working on these materials, and the interest in them is so widespread that need for a coordinated treatise on them has developed. This report deals with the history of the concept of their origin; gives detailed descriptions of their character and mode of occurrence; gives criteria for their recognition; and considers their distribution and consolidation.

The terminology to describe ash flows and the reasons for avoiding the invention of new specific names, or the redefining of old ones, are stated. The terms used are given and defined, so far as possible, by quotations from authoritative sources. The use of descriptive phrases, where generally accepted specific names are unavailable, is the usage adopted.

The evolution of geologic concepts which led eventually to an understanding of the distribution and, in some deposits, the welding of tuffs is traced. Prior to about 1900, geologists argued as to whether these materials represented peculiar volcanic lava flows, or were pyroclastic in origin. The development of a better understanding is traced through the discussion of geologists who reported on the great eruptions of Pelée, Soufrière, and the Valley of Ten Thousand Smokes, and by other geologists who studied analogous ancient eruptions.

Recognition of ash-flow materials involves both field observations and laboratory studies. These are presented in some detail and lead to the conclusion that the ash-flow materials may be recognized by either of these approaches, but for some occurrences both are required. The field relations that are presented for evaluation are: extent, thickness, the relation of overload to welding, jointing, erosional forms, inclusions of alien materials or pumice fragments, devitrification, and the relations to source centers. Experience with distinctive features commonly allows identification of ash-flow deposits even at a distance of many miles.

Laboratory studies that require description and evaluation include chemical analyses, the relation of composition to other features, porosity and its relation to overload and welding, and the temperature of welding. Microscopic studies reveal a large number of variables that demand consideration and discussion of their relative value in identification. These include a variety of primary glassy shard structures, the greatly varied modification of the

shards by compression, welding, and devitrification. These factors may leave clearly significant evidence of origin, or this may be obscured in varying degrees. Experience will allow identification even in the presence of severe modifications, but the development of uncommonly coarse devitrification products may destroy significant structures. The significant characteristics are discussed, and anomalous features which may lead to misinterpretation are discussed and evaluated by the use of photographs.

The minerals in these tuffs comprise the primary minerals (phenocrysts), those resulting from devitrification after emplacement, and those formed in the presence of a vapor phase. The bearing of these on the preeruption, emplacement, and subsequent mineral development is traced.

The wide distribution of ash flows, and the immense volume of the materials represented by some deposits pose many problems in volcanology. The mechanism of emplacement and physical chemistry of the deposits are considered. The source of heat required for welding has long posed a problem to geologists, but a summation of all the geologic and physical factors leads to the conclusion that no exothermic heat source is required. The inherent heat and its conservation by physical relations seems to provide ample heat for welding. The physical chemistry of the welding process is presented.

Typical occurrences of ash-flow deposits, several representative hand specimens, and a wide range of welded and nonwelded tuffs as seen under the microscope, are illustrated, and discussed where clarification of their significance is required.--Auth.

## 11. GEOHYDROLOGY

See also: Areal and Regional Geology 3-2503; Geochemistry 3-2667, 3-2673; Mineral Deposits 3-2765; Engineering Geology 3-2819.

**3-2739.** Feulner, Alvin J. CYCLIC-FLUCTUATION METHODS FOR DETERMINING PERMEABILITY AS APPLIED TO VALLEY-TRAIN DEPOSITS IN THE MAD RIVER VALLEY IN CHAMPAIGN COUNTY, OHIO: Ohio Jour. Sci., v. 61, no. 2, p. 99-106, 4 figs., March 1961.

Cyclic fluctuation methods described by Ferris have been used to compute the coefficient of transmissibility of the valley-train deposits along the Mad River in Champaign County, Ohio. The methods are the same as those described by Ferris, except that only one observation well was used, the center of the stream was assumed to be the suboutcrop from which recharge was initiated, and only the rising stage of the stream and observation well fluctuations were used.

The aquifer constants computed by the cyclic fluctuation method are in essential agreement with those computed from a pumping test and by laboratory analyses. Results of all tests give an average range for the coefficient of permeability of 4,100 to 4,400 g.p.d. per sq. ft. The method, using only one observation well, appears valid for computing values of the coefficient of transmissibility in areas where other data are not available.--Auth.

**3-2740.** Hart, Donald L., Jr. FLUCTUATIONS OF WATER LEVELS IN WELLS: Oklahoma Geology Notes, v. 21, no. 2, p. 41-47, 8 figs., Feb. 1961.

Ground-water levels fluctuate in response to

numerous forces; 2 important causes are changes in the quantity of ground water in storage and changes in the pressures exerted on the aquifer. Examples are shown of fluctuations in Oklahoma caused by: 1) transpiration, 2) river stage, 3) intense rainfall, 4) pumping, 5) seasonal trends, 6) atmospheric pressure, 7) tornado, and 8) earthquake.--Auth.

**3-2741.** Davis, George H. GEOLOGIC CONTROL OF MINERAL COMPOSITION OF STREAM WATERS OF THE EASTERN SLOPE OF THE SOUTHERN COAST RANGES, CALIFORNIA: U.S. Geol. Survey, Water-Supply Paper 1535-B, 30 p., 6 figs., 2 tables, 1961, 19 refs.

Chemical analyses of waters of streams that drain the semiarid eastern slope of the southern Coast Ranges demonstrate that differences in the anion composition, especially in the ratio of bicarbonate to sulfate, are related chiefly to the lithologic character of the rocks exposed in the tributary drainage area.

Where more than half the drainage area of a typical eastern-slope stream is underlain by clastic marine sedimentary rocks of Jurassic and Cretaceous age, bicarbonate generally predominates over sulfate; the ratio of bicarbonate to sulfate, both expressed in equivalents per million, in samples of the streams at low-flow stage ranges from 0.8 to 6. Conversely, where more than half the drainage area is underlain by marine and continental deposits of Tertiary age and continental deposits of Quaternary age, sulfate predominates over bicarbonate, and the ratio of bicarbonate to sulfate in samples taken during the low-flow stage ranges from 0.02 to 0.7.



Organic siliceous marine shale of Tertiary age deposited in a reducing environment is probably the primary source of sulfate in the region. Secondary deposits of sulfate minerals, chiefly gypsum, which are abundant in the continental deposits of late Tertiary and Quaternary age, also contribute sulfate to the stream waters.--Auth.

3-2742. Roberson, Charles E., and H. C. Whitehead. AMMONIATED THERMAL WATERS OF LAKE AND COLUSA COUNTIES, CALIFORNIA: U.S. Geol. Survey, Water-Supply Paper 1535-A, 11 p., 2 maps, graph, 2 tables, 1961, 5 refs.

Thermal springs in 2 areas N. of San Francisco, contain N occurring as ammonia, nitrite, and nitrate. The N compounds show, in general, progressive oxidation with increasing distance down-channel from spring orifices, and with exposure to air during storage of water samples. The resulting increase in content of nitrite and nitrate is accompanied by a decrease in bicarbonate. Oxidation of sulfides when they are present also occurs.--Auth.

3-2743. Ward, Porter E. SALT SPRINGS IN OKLAHOMA: Oklahoma Geology Notes, v. 21, no. 3, p. 83-85, 3 illus., map, table, March 1961.

Salt springs in 9 areas in western Oklahoma discharge brine into surface streams. The spring water contains up to 200,000 p.p.m. of chloride, and the total discharge of sodium chloride salt is estimated to exceed 6,000 tons per day. Studies in progress by the U.S. Geological Survey in cooperation with the U.S. Public Health Service show that the brine results from ground water dissolving subsurface halite in Permian red beds.--Auth.

3-2744. Stewart, J. W. RELATION OF SALTY GROUND WATER TO FRESH ARTESIAN WATER IN THE BRUNSWICK AREA, GLYNN COUNTY, GEORGIA: Georgia, Dept. Mines, Mining & Geology, Inf. Circ. 20, 42 p., 6 figs., 2 tables, 1960, 14 refs.

Salt-water contamination of fresh-water supplies in the Brunswick area is due to the upward movement of connate salt water from the deeper limestone as a result of the reduced head caused by pumping. A minor amount of contamination may result from upward movement of salt water through defective wells that penetrate the upper part of the mineralized zone. Present data indicate that salty water is present in the deeper limestone underlying the area; water from the deepest wells has the highest chloride content. Moreover, during the past few years water from several shallow wells had increased significantly in chloride content.

Since 1943 the artesian head has declined about 30 ft. near the area of heavy pumping. In the center of the cone of depression water levels probably are as much as 20 to 40 ft. below mean sea level. Since 1943 the average daily ground-water withdrawals in the area has increased from 37 to 90 m.g.d. (million gallons per day).

Salt-water contamination in the Brunswick area will depend in part upon the rate of ground-water withdrawals and the corresponding decline of artesian pressures throughout the area. A continued decline in the artesian head will disturb the balance between the salt water-fresh water interface, and a new position of equilibrium will be reached. Any disturbance in the zone of contact between the 2 waters will increase the hazard of salt-water con-

tamination of fresh-water supplies.

A practical approach to the problem of salt-water contamination should include the following: 1) Dispersal of wells so as to avoid concentrated areas of heavy ground-water withdrawals. This would minimize interference between wells and reduce excessive lowering of the water level in the center of the cone. 2) Reduction of the waste of water from uncapped flowing wells in the county. In 1957 the estimated 6 to 8 m.g.d. of water discharged by these wells was wasted; in the adjacent counties of Camden and McIntosh an estimated 20 to 22 m.g.d. of water was wasted by flowing wells.

An intensive ground-water investigation is now in progress to determine the extent of salt-water contamination of fresh-water supplies in the Brunswick area. Comparatively few hydrologic data are available for the area; moreover, much of the information obtained in earlier years should be brought up to date. A systematic ground-water program should include the drilling of several test holes at strategic locations to delineate more precisely the salt water-fresh water interface and to observe the rate of movement of salt water into the fresh-water aquifer by means of a systematic water-sampling program; the testing of drill cores to determine the range of permeability of the limestone aquifer at different depths; construction of piezometric maps to show the changes in artesian pressures throughout the area; and a complete inventory of ground-water withdrawals in the county.--Auth. summ. & concl.

3-2745. Thomas, H. E. GROUND WATER AND THE LAW: U.S. Geol. Survey, Circ. 446, 6 p., 1961.

A nontechnical discussion of the types of water rights and their history, the insecurity of existing rights, and the value of water law as an aid to optimum use of water.--U.S. Geol. Survey.

3-2746. McMaster, William M. INTERIM REPORT ON GROUND-WATER STUDIES IN THE ATHENS AREA, ALABAMA, THROUGH JANUARY 1960: Alabama, Geol. Survey, Inf. Ser. 23, 72 p., 18 figs., 4 pls. (in pocket), 3 tables, 1960.

The population of Athens and vicinity has increased substantially in the past 3 years as a result of expansion and increased employment at Redstone Arsenal in Huntsville, Alabama. Continued population growth and further industrial development of the area will require more water to meet these needs. The municipal water supply for Athens is obtained from 2 wells and a spring.

In Nov. 1958 the U.S. Geological Survey in cooperation with the city of Athens and the Geological Survey of Alabama, began an investigation of the ground-water resources of the Athens area. The purpose of this report is to make available in graphic and tabular form information obtained during the course of that study. The investigation consisted of the following:

1) An inventory was made of all drilled wells and springs and representative dug wells in the area. Water samples were collected from most wells and springs for field analysis of hardness and chloride content. Data from the inventory and chemical analyses are given in tables and the locations of wells and springs are shown.

2) A system of observation wells was established, in which water levels are measured periodically and recorded to determine seasonal variations, reaction to rainfall and vegetative requirements, and the effects of withdrawal of ground water. Fluctuations in

3 of these wells and daily precipitation at Athens are shown graphically.

3) Test wells were drilled to determine geologic structure and stratigraphy and their relation to the occurrence and availability of ground water. Information for 14 test wells completed through Jan. 1960 is given. Locations of the test wells are shown. A preliminary geologic structure map showing the configuration of the top of the Chattanooga shale is included.

4) Pumping tests of suitable wells were made to determine their yields and aquifer properties. Results of 4 pumping tests are presented graphically.

5) Water from 13 selected wells was analyzed to determine the general chemical character of the ground water, and the results are given.

6) The thickness of residual material above bedrock was determined to delineate possible areas of contamination and recharge of ground water.

7) A geologic map of the area was compiled showing the character, distribution, and thickness of the water-bearing formations. A generalized geologic map of the Athens area is shown; the detailed geologic map is planned for completion by July 1, 1960.

8) A map showing the configuration of the ground-water surface in the Athens area was drawn. Thirty-seven wells were measured during Dec. 7-8, 1959, for this purpose.

9) Data was collected on the current use of ground water in the area and the effects of withdrawal on water levels in the area.

This report was prepared as a means of expediting the release of the basic data that are currently needed for the proper planning and development of ground-water supplies for industrial and municipal use in the Athens area. When the investigation is completed a more comprehensive and interpretive report will be released as a Bulletin of the Geological Survey of Alabama.--From auth., p. 4-5.

**3-2747. Sanford, Thomas H. Jr., and Lewis R. West. GROUND-WATER LEVELS IN MADISON COUNTY, ALABAMA, JULY 1956 TO JULY 1959: Alabama, Geol. Survey, Inf. Ser. 22, 42 p. 7 figs., table, 1960.**

The observation-well program in Madison County was begun in July 1956 as a part of a detailed study of ground-water resources of the county made by the U. S. Geological Survey in cooperation with the Madison County Board of Commissioners and the Geological Survey of Alabama. Water-level data were collected from 20 wells, of which 4 were equipped with recording gages and 16 were measured periodically.

The purpose of this report is to release basic data obtained from the observation-well phase of the detailed ground-water study. A more comprehensive report on the ground-water resources of the county, now in preparation, will include geologic data and other hydrologic data obtained in this study, and will supplement data contained in County Report 3.

The study from July 1956 to July 1959 was directed toward a more detailed knowledge of the occurrence, movement, availability, quantity, and quality of ground water in the county. The work accomplished in this study was as follows:

1) Inventoried 250 wells drilled since the completion of previous studies; recorded their location, type of construction, source of supply, depth, water level, and yield.

2) Contracted for and completed 20 test holes in areas where geologic and hydrologic data were

needed.

3) Determined the character, thickness, and distribution of the geologic formations.

4) Prepared a geologic-structure map to relate the geologic structure to the movement of ground water and the occurrence, development, and alignment of openings along joints and bedding planes.

5) Made pumping tests on 26 wells to determine the hydraulic characteristics of the principal aquifers, the interference between wells, and the area of influence caused by pumping.

6) Determined the chemical character of the water in 12 samples from the principal aquifers.--From auth., p. 2-3.

**3-2748. Wood, Perry R. GEOLOGY AND GROUND-WATER FEATURES OF THE BUTTE VALLEY REGION, SISKIYOU COUNTY, CALIFORNIA: U. S. Geol. Survey, Water-Supply Paper 1491, 150 p., 7 figs., 3 pls. (in pocket, incl. 2 col. geol. maps, scale 1:62,500), 13 tables, 1960, 37 refs.**

The Butte Valley region includes an area of about 600 sq. mi., between 121°37' and 122°10'W. and 41°38' and 42°N. The region is near the W. edge of the Modoc plateau. It includes along its western border a part of the Cascade Range, Butte, and Red Rock valleys, the Oklahoma district, and a prominent northwestward-trending fault block (the Mahogany Mountain ridge) which separates Butte Valley from the Oklahoma district and the Lower Klamath Lake marshland.

Geologic units have been divided into 2 groups: volcanic rocks which range in age from Eocene to Recent; and sedimentary rocks which range in age from Pliocene to Recent.

From oldest to youngest the volcanic rocks include: a) predominantly andesitic lavas and pyroclastic rocks comprising the volcanic rocks of the "Western Cascades"; b) older volcanic rocks of the "High Cascades"; c) basaltic flows and pyroclastic rocks E. of the Cascade Range; and d) younger volcanic rocks of the "High Cascades."

Volcanic rocks of the "Western Cascades" are the oldest rocks in the region. They range in age from late Eocene to late Miocene. These rocks are chiefly pyroxene andesite, and andesitic tuff-breccia, but include lesser amounts of basalt, rhyolite, and associated pyroclastic rocks. In most places they are badly decomposed and less permeable than the younger volcanic rocks. They are best exposed in the Klamath River canyon, where the prevailing dips are to the E. and NE. The angle of dip diminishes in these directions from about 15° near the base of the series to nearly zero where the rocks disappear beneath a younger series of volcanic rocks. The volcanic rocks of the "Western Cascades" are at least 12,000 ft. thick.

The older volcanic rocks of the "High Cascades," which unconformably overlie the volcanic rocks of the "Western Cascades," are Pliocene and Pleistocene(?) in age. They consist chiefly of basalt and basaltic andesite that spread out in successive sheets from a chain of northward-trending shield volcanoes built along the crest of the Cascade Range. Here the topography is almost wholly constructional, and even the oldest cones retain much of their original shape. E. of the Cascade Range several large dome-shaped lava cones and most of the northwestward-trending fault block called Mahogany Mountain ridge are composed of volcanic rocks of similar lithology. In most places the older volcanic rocks of the "High Cascades" are highly fractured



and moderately permeable; they serve as a large intake area and ground-water reservoir.

E. of the Cascade Range, basalt of Pleistocene and Recent age issued from vents and fissures and spread out over alluvial deposits and lake sediments in the southern parts of Butte and Red Rock valleys and the Lower Klamath Lake marshland. One of these flows - the Butte Valley basalt - forms the most productive water-bearing formation in the region. In the southwestern part of Butte Valley, where it is overlain by about 20 to 60 ft. of alluvial materials and lake deposits, this basaltic flow is an excellent aquifer. Yields of more than 100 g.p.m. (gallons per minute) for each foot of drawdown are common, and yields of 1,000 g.p.m. for each foot of drawdown have been recorded.

Late Pleistocene and Recent lava flows and cinder cones in the Cascade Range and extensive basaltic extrusions near Sharp Mountain are important chiefly as recharge (intake) areas for ground water.

Sedimentary deposits range in age from Pliocene to Recent. The oldest of these deposits is a massive fresh-water diatomite which underlies a large part of the Oklahoma district. The diatomite is impermeable, but wells penetrating interbedded sand or cindery lapilli lenses in the diatomite may yield moderate quantities of water. Glacial moraines and fluvioglacial outwash deposits of late Pleistocene age occur near the mouth of Butte Creek canyon. These deposits are unstratified or poorly sorted and commonly are only slightly permeable.

Semiconsolidated lake deposits, ranging in age from Pleistocene to Recent, underlie most of the Butte Valley plain. W. of U.S. Highway 97 these deposits are composed principally of impermeable layers of clay, diatomaceous clay, and volcanic ash. However, E. of U.S. Highway 97, and especially near the eastern border of the valley, the lake deposits contain a larger percentage of sand, and permeabilities range from about 50 to 230 g.p.d. per sq. ft. as determined from tests made in 3 pumped wells.

Alluvial-fan deposits on the W. side of Butte Valley range from Pleistocene to Recent in age. They are composed of poorly sorted rock debris derived from the Cascade Range and are only slightly permeable.

Areas mapped as alluvium include thin beds of gravel, sand, clay, and peat covering older lake deposits in Butte Valley and the area around Lower Klamath Lake. They include also small playa deposits, poorly sorted alluvium collected in broad, shallow basins and depressions, and alluvium in present intermittent stream channels. In most places alluvium forms a thin cover resting on lava flows or lake deposits. In general the alluvium is slightly permeable and of little hydrologic importance except in the southwestern part of Butte Valley, where it consists of sand and gravel, ranging in thickness from 20 to 60 ft. and rests on the Butte Valley basalt. In this area the alluvium probably yields moderate quantities of water to wells. Elsewhere the alluvium is largely above the saturated zone and is important chiefly because of its ability to absorb precipitation and surface runoff which percolate through it into underlying rocks.

Linear wedge-shaped talus strips, formed at the foot of precipitous fault scarps, are partly concealed beneath and probably interfinger with alluvium and lake deposits. The blocky talus debris is very permeable and, where saturated, yields water readily to wells.

E. of the Cascade Range, block faulting is the dominant structural feature. The faults are normal,

and displacement is almost wholly vertical. Vertical displacements range from a few feet along minor faults to perhaps several thousand feet along major faults; there are no appreciable horizontal displacements.

Butte Valley is a complexly downfaulted basin nearly surrounded by well-preserved fault scarps of the late Pleistocene and Recent age. Ground water moves eastward and northeastward across the valley into the buried talus and volcanic rocks that compose the Mahogany Mountain ridge, and may flow through that ridge to supply recharge to the area to the E. The direction of water movement in Red Rock Valley and in the Oklahoma district was not determined.

Records of water-level fluctuations in observation wells show that water levels recover each winter, and during the period 1951-1954 there was little over-all change in the height of yearly recovery.

Ground-water recharge in the southern part of the region occurs mainly by seepage loss from perennial spring-fed streams and unlined canals along the western margin of Butte Valley, by seepage loss from small spring-fed streams that discharge onto alluvial fans, and along the N., W., and S. sides of the valley by lateral movement from the volcanic rocks. In irrigated tracts throughout the area some recharge probably occurs by deep percolation of irrigation water.

Ground water is discharged by natural means and by pumping. In Butte Valley about 21,000 acre-ft. of ground water was used for irrigation in 1953. In Red Rock Valley pumping of ground water for irrigation purposes was negligible. In the Oklahoma district ground water for irrigation and domestic requirements is supplied by springs and flowing and pumped wells.

The quality of most of the ground water in the region is satisfactory for most uses, but in the E.-central part of Butte Valley some wells yield water containing high percentages of Na, probably derived from buried playa deposits.

The chemical quality of the surface water is such that it can be used for most purposes. However, analyses of water from Meiss Lake show high concentrations of dissolved solids, ranging from 473 to 1,380 p.p.m., and high percentages of Na, ranging from 75 to 91. Here the salts have been concentrated by evaporation of the lake water.--Auth.

**3-2749.** Voegeli, Paul Thomas, and Lloyd A. Hershey. RECORDS AND LOGS OF SELECTED WELLS AND TEST HOLES, AND CHEMICAL AND RADIO-METRIC ANALYSES OF GROUND WATER, PROWERS COUNTY, COLORADO: Colorado, Water Conserv. Board, Basic Data Rept. 1, Ground Water Ser., 41 p., fig., map (in pocket), 5 tables, 1960.

This report is intended to serve 2 purposes: (1) to make available to the public basic ground-water data useful in planning and studying water-resources development, and 2) to supplement an interpretive report that will be published later.

The records were collected during the period 1955-1958 as a part of the investigation of the geology and ground-water resources of Prowers County, Colorado, made by the U.S. Geological Survey in cooperation with the Colorado Water Conservation Board. The interpretive report by P. T. Voegeli, Sr., and L. A. Hershey will be published as a Geological Survey Water-Supply Paper entitled "Geology and ground-water resources, Prowers Co., Colorado."

This report is most useful in predicting conditions likely to be encountered when drilling a new well. The person considering the new well can spot the proposed

site on the map and examine the records of nearby wells. From table 2, he can determine what success his neighbors may have had; from table 3 he may determine the type of materials likely to be encountered; and from tables 4 and 5 he may determine whether the quality of water is likely to be suitable for its intended use. Where the information in tables 2-5 are representative only of shallow water-bearing formations, table 1 may be useful in determining whether it is practical to drill deeper in search of water.

The report also is useful when repairing wells, determining the extent of geologic formations, and planning large-scale developments of water supply. These and other uses of the report will be facilitated upon release of the interpretive report.--From introd.

**3-2750.** Weist, William G., Jr. RECORDS AND LOGS OF SELECTED WELLS AND TEST HOLES, AND CHEMICAL ANALYSES OF GROUND WATER, YUMA COUNTY, COLORADO: Colorado, Water Conserv. Board, Basic Data Rept. 2, Ground Water Ser., 41 p., fig., map (in pocket), 5 tables, 1960.

This report is intended to serve 2 purposes: 1) to make available to the public basic ground-water data useful in planning and studying water-resources development, and 2) to supplement an interpretive report that will be published later.

The records were collected during the period 1956-1958 as a part of the investigation of the geology and ground-water resources of Yuma County, Colorado, made by the U. S. Geological Survey in cooperation with the Colorado Water Conservation Board. The interpretive report by W. G. Weist, Jr., will be published as a Geological Survey Water-Supply Paper entitled "Geology and ground-water resources of Yuma County, Colorado."

This report is most useful in predicting conditions likely to be encountered when drilling a new well. The person considering the new well can spot the proposed site on plate 1 and examine the records of nearby wells. From table 2, he can determine what success his neighbors may have had; from tables 3 and 4 he may determine the type of materials likely to be encountered; and from table 5 he may determine whether the quality of water is likely to be suitable for its intended use.

The report also is useful when repairing wells, determining the extent of geologic formations, and planning large-scale developments of water supply. These and other uses of the report will be facilitated upon release of the interpretive report.--From introd.

**3-2751.** Rasmussen, William C., and others. WATER RESOURCES OF SUSSEX COUNTY, DELAWARE, WITH A SECTION ON SALT-WATER ENCROACHMENT AT LEWES: Delaware, Geol. Survey, Bull. no. 8, 228 p., 14 figs., 10 pls. (9 in pocket), 24 tables, Dec. 1960, 94 refs.

Sussex County is in the Atlantic Coastal Plain. Its relatively flat, featureless topography is characterized by 2 terracelike surfaces; the lower one rises from sea level to about 40 ft. above sea level, and the higher one rises inland from 40 to about 60 ft. above sea level. Peculiar landforms of low relief, broad ovals, similar to the "Carolina bays," and to the "New Jersey basins" are common on the sandy flat divides in Sussex County. Hydrologically, they are sites of much ground-water discharge, by evapo-

transpiration, from meadow and marsh of lush vegetation.

The geology of the county is structurally simple. It is characterized by a sedimentary wedge which thickens southeastward from 3,500 ft. to more than 8,000 ft. The strata form a homocline which dips southeastward at rates ranging from 10 to 70 ft. per mi. Above the Paleozoic(?) and Precambrian crystalline basement complex, are sediments of the Triassic(?), Cretaceous, Tertiary, and Quaternary systems. Only the uppermost few hundred feet of this column of sediments provide water to wells. The most important aquifer consists of sand and silty sand of the Pleistocene series and the Pliocene(?) series which fill a valley system carved on a now buried surface of Miocene rocks. The Miocene rocks are relatively unconsolidated clays and sands and contain several artesian aquifers which as of 1959 have not been used extensively.

Streamflow records from 4 gaging stations in the county and 2 others nearby, and base-flow measurements from 8 additional sites in 1955-1958 provide the basis for the surface-water analyses presented in this report. From these records it has been possible to construct curves for each of the 7 major drainage basins, showing flow duration, low-flow frequency, average discharge, storage requirement, and flood frequency.

In addition, chemical analyses of water from 20 stream sites indicate that the surface waters are low in dissolved solids and soft, but have a slight to excessive Fe content. The pH ranges from 5.2 to 6.7. The average daily use of surface water in Sussex County is estimated at 11 m.g.d. (million gallons per day) based on 1957 data.

Sedimentary and hydrologic analyses of 32 samples taken from outcrops indicate that the surficial sediments are medium-grained sands, having an average porosity about 40% and an average coefficient of permeability of 420 gallons per day per square foot. Such material is capable of a high infiltration rate.

Analyses of 142 water samples from 97 wells reveal that the ground waters are, in general, low in dissolved-solids content, soft to slightly hard, low in chloride, and that troublesome amounts of Fe are present in some wells, but absent in others. The pH ranged from 3.4 to 9.9.

Nearly all of the ground water used in the county is obtained from 4 principal aquifers: about 74% is obtained from the Beaverdam sand and the Brandywine formation which constitute the shallow water-table aquifers of the Pleistocene-Pliocene(?) series; an additional 20% is withdrawn from the Manokin aquifer of the Miocene series; and the remaining 6% is withdrawn from the Pocomoke and Frederica aquifers, also of the Miocene series.

Total use of ground water was about 19.1 m.g.d. in 1957. Industrial use accounted for 11.5 m.g.d.; municipal supply about 4.0 m.g.d.; rural domestic uses about 2 m.g.d.; farm-stock uses about 1.1 m.g.d.; and irrigation about 0.4 m.g.d.

A special investigation of salt-water contamination was made at Lewes. The city well field was contaminated by salt water during World War II, owing to heavy pumping, coincident with the dredging of a canal half a mile away. A new well field was constructed 1.5 mi. inland in 1945 and expanded in 1954. Well-field tests made in both those years indicate high potential capacity for the field. At the old well field, in the period 1945 to 1954, pumping was moderate to small, and the quality of water returned to normal. This indicated that the salt-water front



and retreated due to fresh-water recharge.

It is estimated that at optimum use no more than 1 m.g.d. per sq. mi. could be taken from ground and surface sources. It is very unlikely, however, that such a large quantity, and the requisite network of wells, pipes and check dams, will ever be realized. However, it is concluded that there are large quantities of water readily available for development in many parts of Sussex County.

Sussex County has adequate, and in places, abundant water resources. During wet seasons water is in excess, both in the lowland areas, and in the broad, swampy divides, so that extensive drainage is necessary. In a few places, malodorous, hard, or Fe-containing waters present problems in treatment. Beneath a narrow strip along the shores of the Atlantic Ocean and Delaware Bay, some salt-water encroachment has occurred. In the county-at-large, however, water of quality suitable for most purposes can be developed from streams or from wells in sufficient quantity for agricultural, municipal, or industrial supply.--Auth.

3-2752. Palmquist, W.N., Jr., and Francis R. Hall. RECONNAISSANCE OF GROUND-WATER RESOURCES IN THE BLUE GRASS REGION, KENTUCKY: U.S. Geol. Survey, Water-Supply Paper 1533, 39 p., 8 figs. incl. maps, graphs, 3 pls. (in pocket), 4 tables, 1961, 50 refs.

In the Blue Grass region probably less than half of the attempts to obtain adequate domestic water supplies from wells drilled in bedrock have been successful. The most favorable areas for obtaining ground water in the bedrock are those where thick limestone beds containing little or no shale occur at and below stream level. Areas underlain by shale or interbedded shale and limestone generally are less favorable. In general, more of the wells drilled in valleys are successful than those drilled on ridge-tops. Large supplies of ground water can be obtained in many places from the alluvium along the Ohio River, but the alluvium along tributary streams generally is too fine-grained to yield large quantities of water. The water from wells in the Blue Grass region generally is of the calcium bicarbonate type and is hard to very hard. About one-eighth of the wells are reported to yield water containing undesirable amounts of common salt, and about one-fifth of the wells yield water containing noticeable amounts of hydrogen sulfide.--Auth.

3-2753. Bingham, James W. BASIC GEOLOGIC AND GROUND WATER DATA FOR CLAY COUNTY, MINNESOTA: Minnesota, Dept. Conserv., Div. Waters, Bull. no. 8, 138 p., 16 figs., 3 pls., 4 tables, March 1960, 23 refs.

Clay County is in western Minnesota about 130 mi. S. of the Canadian boundary. It has an area of about 1,055 sq. mi.

Since World War II there has been an unprecedented increase in the demand for additional ground-water supplies for municipal, industrial, and agricultural purposes. This trend has been particularly evident in Clay County. The purpose of this investigation is to amplify a previous study of the Fargo-Moorhead area, North Dakota and Minnesota, and extend the coverage to include the entire county. This report makes available all the basic data that were obtained from 1941 through 1956. The report that will eventually follow will interpret the data that have been obtained and attempt to appraise the

ground-water resources so that they may be utilized wisely and efficiently.

The subsurface geologic formations of Clay County include the Precambrian crystalline bedrock, Cretaceous shales and sandstones, and Pleistocene glacial deposits.

Little is known about the Precambrian bedrock and Cretaceous strata because they are buried beneath the glacial deposits and relatively few wells and test holes have been drilled into them. The crystalline basement rocks, which underlie the entire county, are overlain in the extreme western part of the area by a more or less continuous mantle of Cretaceous shales and sandstones. Elsewhere in the county the Precambrian bedrock is covered by glacial deposits.

The Pleistocene glacial deposits include till (materials deposited directly from the ice), glaciofluvial sediments (materials deposited by meltwater), and glacial-lake deposits. The glacial drift has been reported to range in thickness from less than 100 to more than 300 ft.

Buried in or associated with the tills are lenses, layers, and channel deposits of sand and gravel. These deposits furnish water to the majority of wells in Clay County. Above the tills and associated glaciofluvial deposits in the basin of glacial Lake Agassiz are extensive glacial-lake deposits of clay, silt, sand, and gravel. These lake beds reach a maximum thickness of about 150 ft. in the western part of the county which is near the center of the Lake Agassiz basin. The beach sands and gravels and the silts of glacial Lake Agassiz yield water to some domestic wells.

In 2 press releases, the U.S. Geological Survey in 1947 described a linear deposit of sand and gravel more than 15 mi. long and from 0.5 to 1.5 mi. wide. This deposit extends in a N.-S. direction through Tps. 137, 138, 139, and 140 N., R. 47 W. Several large-capacity wells have been developed in this deposit for irrigation and for the municipal supply of the city of Moorhead.--From introd.

3-2754. Harbeck, G. Earl, Jr., and others. EFFECT OF IRRIGATION WITHDRAWALS ON STAGE OF LAKE WASHINGTON, MISSISSIPPI: U.S. Geol. Survey, Water-Supply Paper 1460-I, p. 359-388, 17 figs., 2 tables, 1961, 4 refs.

The increase in the amount of water pumped from Lake Washington, Mississippi, for supplemental irrigation caused concern among residents of the area over the possible effect of the irrigation withdrawals on the stage of the lake, which is used for recreation. Records of the stage of Lake Washington, ground-water levels in the area, and meteorological data were used to determine the seasonal variation in the amount of seepage into and out of the lake. In Spring, the nearby Mississippi River is high, and the net seepage into Lake Washington is much greater than the out seepage during fall, when the river is low.

Irrigation withdrawals in 1957 were small compared with both rainfall on the lake and seepage into the lake. If the rate of irrigation withdrawals ever became large enough to lower the lake level by more than a few inches, those withdrawals would be partly balanced by an increase in the amount of seepage into the lake when the ground-water level in the area is high. Thus an increase in the amount of water withdrawn would not result in lowering the lake level by an equivalent amount.--Auth.

3-2755. Konizeski, Richard L., and others. PRELIMINARY REPORT ON THE GEOLOGY AND

**GROUND-WATER RESOURCES OF THE NORTHERN PART OF THE DEER LODGE VALLEY, MONTANA:** Montana, Bur. Mines & Geology, Bull. 21, 24 p., 7 figs., pl., 2 tables, 1961, 16 refs.

The Deer Lodge Valley, an intermontane basin in western Montana, is bounded by relatively low mountains on the E. and by the rugged Flint Creek Range on the W. Agriculture is the leading occupation in the area studied. The climate is semiarid; most of the cultivated land is irrigated.

Rocks ranging in age from Precambrian to early Tertiary(?) crop out in the marginal highlands. The valley fill in the area consists of a relatively great thickness of Tertiary sediments overlain locally by a thin mantle of Quaternary deposits. The Quaternary deposits yield adequate water for stock, domestic, and, locally, for limited irrigation use. The Tertiary sediments are generally less permeable but have a much greater thickness than the Quaternary deposits and provide adequate yields for stock and domestic use. Yields range from less than 10 g. p. d. (gallons per minute) per foot of drawdown to as much as 40 g. p. m., locally, when wells are adequately screened and developed.

Recharge to the ground-water reservoir occurs primarily by infiltration from streams and irrigation water and secondarily by direct infiltration of precipitation and snowmelt. Discharge of water from the reservoir occurs mainly by evapotranspiration and by hydraulic discharge into streams. The ground water generally moves toward the flood-plain area from the valley sides. On the flood plain, ground water generally moves northward, but there is a component of flow toward the river.--R. L. Konizeski.

**3-2756.** Reeder, H. O., and others. **GROUND-WATER LEVELS IN NEW MEXICO, 1956:** New Mexico, State Engineer, Tech. Rept. 19, 251 p., map, 19 figs., 52 tables, 1960, 36 refs.

The annual measurements of water level in the observation wells in the various areas in Jan. or Feb. 1957 with changes in water level in 1956 are tabulated in the report, and the seasonal and daily measurements in 1956, are included. Water-level changes for 1956 are discussed and presented graphically on maps for each area of observations.

The areas of observation are as follows: House, Clovis, Portales Valley, Causey-Lingo, Tatum-Lovington-Hobbs, Roswell basin, Carlsbad, Hondo Valley, Estancia Valley, Tularosa-Alamogordo, Crow Flats, Sunshine Valley, Hot Springs basin, Grants-Bluewater, and the Animas, Playas, Lordsburg, Virden, and Mimbres valleys.

A network of observation wells in which water levels are measured periodically is necessary to record changes in ground-water storage in areas where the ground-water resources are being developed. Such a network provides information on the capacity of the aquifer and the probable life of the supply. Water levels were measured in 1,600 wells in Jan. or Feb. 1957 and periodically in 505 of these wells during 1956. Recording gages were maintained on 32 of the wells.

In addition to measurements of water levels, other related data were collected in connection with the observation-well program. About 855,000 acres of land was irrigated in 1956 in New Mexico of which 444,000 acres was irrigated entirely with ground water and 130,000 acres was irrigated with a combination of ground and surface waters.

Precipitation was less in 1956 throughout New Mexico than in any other year in the 65 years of recorded

weather. In addition, a long period of below normal precipitation preceded 1956, resulting in a drought worse than any in the last 50 years. In 1956 about 1,320,000 acre-ft. of ground water was pumped for irrigation.

Water levels continued to decline in 1956 in areas where ground water is used for irrigation. In general, declines were smaller than in 1955 in Animas Valley, Mimbres Valley, and Lea County, and about the same or greater in the other areas of observation of water levels. Water levels reached record lows in most observation wells in New Mexico except in parts of the Roswell basin and parts of the Carlsbad area.--Auth.

**3-2757.** Trauger, Frederick D. **AVAILABILITY OF GROUND WATER AT PROPOSED WELL SITES IN GILA NATIONAL FOREST, SIERRA AND CATRON COUNTIES, NEW MEXICO:** New Mexico, State Engineer, Tech. Rept. 18, 20 p., 2 figs., 3 pls., 2 tables, 1960, 3 refs.

One proposed well site in Catron County and 4 sites in Sierra County were examined. The proposed sites are in high mountainous country. The geology is complex; faulted and folded marine sedimentary rocks of Paleozoic age and volcanic rocks of Tertiary age occur in the vicinity of Lake Valley in Sierra County; volcanic, lacustrine, and fluvial rocks, mostly of Tertiary age, occur in Catron County.

Ground water in quantities sufficient to supply stock wells and camp facilities can be developed where needed. In general, wells should be drilled more than 500 ft. deep, and water levels in the wells probably will be deep. Water in some of the areas may be under artesian pressure.

The chemical quality of the ground water in all areas is such that the water probably is suitable for livestock and human use.--Auth.

**3-2758.** Gordon, Ellis D. **GEOLOGY AND GROUND-WATER RESOURCES OF THE GRANTS-BLUEWATER AREA, VALENCIA COUNTY, NEW MEXICO.** With a section on Aquifer Characteristics, by H. O. Reeder, and a section on Chemical Quality of the Ground Water, by J. L. Kunkler: New Mexico, State Engineer, Tech. Rept. 20, 109 p., 14 figs., 2 pls. incl. geol. map (in pocket), scale approx. 1 in. to 1 mi., 12 tables, 1961, 81 refs.

Ground water has been developed extensively for irrigation and industrial use in the Grants-Bluewater area of N.-central Valencia County. About two-thirds of the nation's known U reserves are in or near this area. The development of ground water has created many problems; this report appraises the problems and their causes.

The principal aquifer in the area is formed by the Glorieta sandstone [Permian] and the overlying San Andres limestone [Permian], which crop out on the flanks of the Zuni Mountains and underlie the eastern two-thirds of the area. Interbedded alluvium and basalt of Quaternary age form an aquifer of secondary importance.

The Glorieta sandstone is less permeable than the San Andres, and few wells tap it exclusively. The Glorieta transmits water to the overlying San Andres limestone, however, as pumping decreases the hydraulic pressure in the San Andres. Well-connected cavernous zones and solution channels have developed in the San Andres, and the transmissibility of the limestone is great in most places.

The alluvium and basalt yield adequate quantities



of water for stock and domestic use at most places and for irrigation and municipal use locally.

The first irrigation well was drilled in 1944, and the number had increased to 23 in 1951. The use of ground water for irrigation reached a peak of 12,600 acre-ft. in 1954 and has since decreased. Several of the irrigation wells have been converted for industrial and municipal supply, and ground water for these uses increased from 250 acre-ft. in 1951 to 6,000 acre-ft. in 1957. The total withdrawal stabilized at about 13,000 acre-ft. per year from 1950 to 1957.

Withdrawal of ground water has caused water levels to decline 40 to 45 ft. N. of the village of Bluewater and 18 to 20 ft. from Bluewater SE. to near Grants.

The largest yields are obtained from wells penetrating both of the major aquifers in the southwestern part of the Grants-Bluewater Valley between Bluewater and Milan. The yields of wells in that area range approximately from 500 to 2,200 g.p.m. (gallons per minute); the specific capacities of the wells that were measured averaged 200 g.p.m. per ft. of drawdown. The specific capacity of only one well that taps the alluvium and basalt was determined; it was 31 g.p.m. per ft. of drawdown.

The chemical quality of the water in both aquifers varies widely in short distances. The quality of water yielded by a few wells that tap the San Andres limestone has changed in the last decade; some water has improved in quality and some has deteriorated, according to the proximity of the recharge area. The agricultural utility of water from both aquifers generally is satisfactory, although the salinity hazard of water in some areas is high. Water used for the municipal supply of Grants is too hard and too saline to be desirable, and the sulfate concentration is sufficiently high to impart an objectionable taste. The water of best chemical quality is obtained from both aquifers between Bluewater and Milan, where the largest average yields also are obtained.--Auth.

**3-2759.** National Speleological Society. **BARTON HILL PROJECT. A STUDY OF THE HYDROLOGY OF LIMESTONE TERRAIN, SCHOHARIE, NEW YORK:** *Its*; Bull., v. 23, pt. 1, p. 1-30, 19 figs., Jan. 1961, 10 refs.

Barton Hill is the source area for the water supply of Schoharie. The village obtains its water from 3 springs (Youngs, Dugans, and Truax). In late summer of 1959, after a prolonged drought, the springs ceased to flow and the village was without a water supply for a short period of time.

Barton Hill covers an area of about 3,000 acres and is formed primarily of limestones, Middle Ordovician to Middle Devonian in age. These limestones total about 600 ft. thick and dip  $1^{\circ}$  or  $2^{\circ}$  to the SW. Solution features are developed along 2 sets of joints at N.  $25^{\circ}$ E. and N.  $85^{\circ}$ W. Flow of ground water is down dip along the solution openings.

Dye tests showed that water for the springs has its source in sink holes, crevices, and caves in Barton Hill. The largest spring, Youngs spring, is the only perennial one supplying the village. It yields about 144,000 g.p.d. (gallons per day) in normal dry season. The consumption of water by the village in summer is about 200,000 g.p.d. A supplement of 4,000,000 gallons is needed to carry the village through the 6-week dry season.

It is estimated that 720,000,000 gallons of ground

water are available in Barton Hill. This is a little less than 10 times the annual consumption of water by Schoharie. Most of the ground water is discharged through springs and seeps without being utilized by the village.

Studies of the caves and other underground openings in Barton Hill by the National Speleological Society in 1960, show that it is not practicable to increase storage by impounding water in the caves; lack of knowledge concerning joint openings and related features make such storage unpredictable.

The best storage area is Cow sink where 4,500,000 gallons could be impounded by a dam 5 ft. high. This sink connects directly with the main water supply point via solution openings but its floor is impervious making storage possible.

Pollution is not a problem in the village water supply at present. However, steps should be taken to prevent future pollution - catchment basins at the springs should be covered; disposal of garbage and dead animals on Barton Hill should be prohibited; septic tanks for sewage disposal should be strictly controlled.--Auth.

**3-2760.** Davis, R. W., and others. **PROGRESS REPORT ON WELLS PENETRATING ARTESIAN AQUIFERS IN SOUTH DAKOTA:** U.S. Geol. Survey, Water-Supply Paper 1534, 100 p., 2 figs., 9 pls. (3 in pocket), table, 1961, 29 refs.

Artesian aquifers underlie most of South Dakota and large areas in adjacent states. About 15,000 wells have been completed since 1881 in these aquifers within South Dakota. Many wells that originally flowed have ceased to flow and have been abandoned, and others have been equipped with pumps. Many thousands, however, continue to flow. This report presents data collected through June 1958 and includes records of 1,045 flowing and nonflowing artesian wells.

Sufficient information is not available at present (1958) to permit a detailed description of the geologic and hydrologic properties of artesian aquifers or their correlation in South Dakota. The description of the various aquifers given in this report is, therefore, necessarily a general one.--Auth.

**3-2761.** Cross, Whitman, II. **WATER-WELL DATA, WESTERN PART OF ALBEMARLE COUNTY:** Virginia, Div. Mineral Resources, Inf. Circ. 2, 16 p., map, 3 tables, 1960.

A data compilation of approximately 300 drilled wells in the western half of Albemarle County, Virginia. The area of study is bounded on the N. by Green County, on the E. approximately by U.S. Route 29, on the S. by Nelson County, and on the W. by Augusta and Rockingham counties along the crest of the Blue Ridge.

The classification of well sites is based on their locations with respect to the topography at each site. The topographic locations listed in the tables of well data are hill, ridge, flat, slope, and draw. Unless otherwise noted, draws include valleys because wells on both sites have similar characteristics.

In the western half of Albemarle County there are 2 zones of ground-water storage: 1) the lower residuum (saprolite) where the water is held in the pores of the material, and 2) within the fractures in the underlying bedrock. The amount of water available to the underground reservoir is dependent upon the rainfall and the porosity and permeability of the surface materials, the angle of slope, and the rate of evapotranspiration. The number and size of fracture open-

ings decrease with depth so that below 300 ft. there is little chance of intersecting a water-bearing fracture. The majority of such fractures are encountered the first 100 ft. of bedrock. However, there are sev-

eral large producing wells in the western half of Albemarle County that are reported to receive recharge from fractures below 500 ft. in depth.--From auth., p. 1-3.

## 12. MINERAL DEPOSITS

See also: Geologic Maps 3-2489, 3-2491; Areal and Regional Geology 3-2510; Geochemistry 3-2665, 3-2668, 3-2669; Mineralogy 3-2706; Igneous and Metamorphic Petrology 3-2726, 3-2727; Engineering Geology 3-2814, 3-2815, 3-2818.

**3-2762.** Mining World. CATALOG, SURVEY & DIRECTORY NUMBER: Its: v. 23, no. 5, 262 p., Apr. 25, 1961.

Contains: 1) papers on technological advances of the minerals industries in 1960; 2) equipment awards for 1960; 3) review of 23 metals and minerals; 4) review of mining in 18 states and regions of the United States during 1960; 5) mining report on 58 countries outside the United States; 6) directory of U. S. mining companies; 7) United States ore buyers guide; 8) catalog index of equipment and manufacturers. Tables show Minnesota, Michigan, and Wisconsin iron range ore shipments, 1958-1960; U.S. open pit mine production for 1957-1960; U.S. underground mine production for 1955-1960; U.S. mine production of key metals from 1900 to 1961; production of minerals by states.--A. C. Sangree.

**3-2763.** Røxtrom, Eric. CRAELIUS AUTOMATIC CORE ORIENTATOR: Can. Mining Jour., v. 82, no. 3, p. 60-61, illus., March 1961.

The dip of a formation can be quickly obtained each time core is taken by using the Craelius core orientator in inclined drill holes of small diameter and in areas where magnetic disturbances prevent the use of a compass or similar orientation device. The Craelius instrument can also be used in horizontal and upwards-inclined holes.

Employing a series of sliding pins and a small ball, a record is obtained which relates to the vertical plane through the longitudinal axis of the drill hole.--W. C. Peters.

**3-2764.** Godwin, C. V. AIR TRANSPORT IN THE DIAMOND DRILLING INDUSTRY: Can. Mining Jour., v. 82, no. 3, p. 57-60, 4 illus., March 1961.

A description of Canadian regulations governing charter aircraft is given with comments on aircraft services in exploration drilling.

Small aircraft such as the Cessna 180 are recommended for reconnaissance, for movement of personnel, and for emergencies. Medium aircraft, including the Norseman, Beaver, and Otter are of wide utility. Large aircraft such as the DC-3 with wheel-skis for winter operation and the Canso for summer are particularly recommended for large and concentrated demands and will carry loads in excess of 5,000 lbs. at rates of \$1.50 to \$1.60 per mi.

Suggestions are included for planning exploration drilling operations with aircraft support.--W. C. Peters.

**3-2765.** Viktorov, S. V. THE USE OF THE GEOBOTANICAL METHOD IN GEOLOGICAL AND HYDROGEOLOGICAL INVESTIGATIONS: U. S. Atomic

Energy Comm., [Pub.] AEC-tr-3968, 219 p., 35 figs. incl. illus., graphs, 13 tables, March 1960, approx. 330 refs.

The geobotanical method in geology and hydrogeology consists of the use of composition, structure, and rhythms of development of plant cover as auxiliary indicators to determine the borders of diverse lithologic and sometimes stratigraphic horizons, and for prospecting for certain minerals, for instance, bitumens, oil, salts, shallow ground water.

The geobotanical method was evoked by demands of geological investigation to facilitate the work of the geologist in forests, in regions lacking rock outcrops and in deserts. Future development of the method is linked to the application in geology of aerial photography and the use of vegetation as an indicator in aerial geological interpretation.

A. Karpinsky, P. A. Ososkov, N. K. Vysotsky were the founders of the geobotanical method in geology. Vitruvius should be regarded as founder of the method in hydrogeology.

It is now possible to construct a scheme of lithological and hydrogeological adaptabilities in plant associations and by means of this to facilitate the work of both the geologist and hydrogeologist.

The phenomena of lithological and hydrogeological adaptability of plant associations have been described for the most diverse parts of the Soviet Union, for the tundras, forests, forest steppe zone, for the steppes, semi-deserts, deserts, and mountains.

The widespread geographic distribution of such phenomena and their reflection in the works of geologists, geographers, geobotanists, and others suggests some separate group of laws.

The lithological and hydrogeological adaptability of vegetation appears in its own way in each more or less climatically homogeneous region, and these phenomena will be applicable in similar regions.

The basic subjects of geoinicator studies are the rock type and its plant cover. The rock type taken together with the vegetation covering it always represents a more or less complex system. As the elements of this system one should consider the individual geochemical landscape, in the sense B. B. Polynov used this term. Only in erroneous simplification would one attempt to reduce the plant cover of a rock to any single association.

The rock and its plant cover are in a state of constant interdevelopment and interaction. The soil-forming process is basic here, although considerable complication is introduced by relief processes and ground water, as well as a number of other factors, among which are agricultural activities.

One of the most important initial tasks in geoinicator studies is the establishment of this series of associations which is characteristic of a given rock type. At the foundation of this series lies the gradual change in associations during the processes of rock weathering and soil formation.

Investigating with geoinicators is a process of discovering distinctions in the plant cover on certain rocks or under different hydrogeological conditions.



The basic groups of distinctions which we have used in the present work were the following: ecologico-physiognomic and floristic distinctions, differences in vitality, in the plant cover structure and in developmental rhythm.

The ecologico-physiognomic distinctions show the most marked form of difference in the plant cover on diverse rocks and are very clearly reflected in aerial photos.

Floristic distinctions in the plant cover on various rocks can have a different character. Those cases belong here where associations which are closely related in external appearance (for instance, the various steppe associations), existing on different rocks, are composed of different species and have a low floristic community factor. Here too belong the phenomena of strict adaptability of individual species or intraspecific forms to definite rocks or to specific substances in the earth's crust.

Differences in the vitality of plants under differing circumstances has found, up to now, an extremely limited application in geoindicatory investigations. One would think they should find use in the study of geochemical manifestations of tectonic disturbances and hydrogeological investigations.

Structural distinctions embrace, first of all, peculiarities in the outlines and configurations of various associations, and secondly, differences in the nature of distribution of the very same species on diverse rocks.

Discovery of these distinctions requires the widespread use of aerial methods, studies of aerial photos, as well as making a large number of measurements and computations with their subsequent statistical processing. These distinctions may be utilized in compiling hydroindicatory maps (maps showing the depth of occurrence of ground water and its mineralization), lithological maps, or studies of tectonic localities.

Phenological distinctions embrace differences in the rhythm of development of some particular species on various rocks. This group of distinctions has particularly great merit in indicating ground moisture conditions as well. It is still very poorly developed.

Investigating in Central Asia has shown that the geobotanical method can be applied: a) in compiling lithological maps; b) in compiling maps of the depth and the chemical properties of ground water (at depths not exceeding 25 m.); c) in compiling selective maps of the occurrence of specific rocks; d) in compiling schemes for the distribution of plots with considerable bituminosity in the surface horizons of the ground and soil; e) the discernment and fixation on a map of tectonic disturbance lines; and f) prospecting for certain minerals.--M. Russell.

**3-2766.** Moiseenko, U.I. BIOGEOCHEMICAL SURVEYS IN PROSPECTING FOR URANIUM IN MARSHY AREAS: *Geokhimiya*, in translation, 1959, no. 1, p. 117-121, table, pub. 1960, 7 refs.

The results of the investigation show that biogeochemical prospecting for U is feasible in the marshy areas of the taiga [U.S.S.R.] by using soils and plants. The U concentration in plants is lower, as a rule, than in the soils, and in searching for U in marshy areas, examination of soils must be given preference.--Auth. summ.

**3-2767.** Aleskovsky, V.B., and others. APPLICATION OF THE BIOGEOCHEMICAL METHOD TO PROSPECTING FOR NICKEL ON THE KOLA PENINSULA: *Geokhimiya*, in translation, 1959, no. 3, p.

330-338, 8 figs., 3 tables, pub. 1960, 6 refs.

The Ni content in plants and soils depends on its content in the bedrock. The biogeochemical method may be used in the environment of Kola peninsula for prospecting for Ni ore deposits. In prospecting it is best to use plant samples because they are easily analyzed. Birch leaves are good concentrators of Ni and may be collected during the summer and autumn months.--Auth. summ.

**3-2768.** Kudryashova, V.I. HYDROTHERMAL MINERALIZATION IN CONNECTION WITH TRAP-ROCK OF THE MIDDLE COURSE OF THE NIZH-NYAYA TUNGUSKA: *Akad. Nauk SSSR, Izvestiya, Geol. Ser.*, in translation, 1959, no. 9, p. 22-28, pub., 1961, 19 refs.

E. of Tur, in the middle course of the Nizhnyaya Tunguska, is an area made up exclusively of trap-rock with associated hydrothermal mineral deposits. Geochemical similarities show that all are related to a single trap-rock magma, but mineral diversity has been caused by different physical-chemical conditions of mineralization.--M. Russell.

**3-2769.** Miller, Robert J.M. WALL-ROCK ALTERATION AT THE CEDAR BAY MINE, CHIBOUG-AMAU DISTRICT, QUEBEC: *Econ. Geology*, v. 56, no. 2, p. 321-330, 5 figs., table, March-Apr. 1961, 7 refs.

The Cedar Bay mine, northern Quebec, is entirely within the Chibougamau gabbro-anorthosite complex. The Cu and Au minerals occur as replacement bodies and possibly cavity-filling along faults and shears. Because the host rock is essentially of one composition, an exceptional opportunity for the study of alteration is available. The differences in modes of occurrence and quantities of alteration minerals make it possible to delimit alteration zones, which are parallel to the ore shoots. The thickness of the alteration zones varies directly with the thickness of the ore shoots. The use of these zones is valuable in estimating the proximity to ore.--Auth.

**3-2770.** Ward, Hector J. THE PYRITE BODY AND COPPER OREBODIES, CERRO DE PASCO MINE, CENTRAL PERU: *Econ. Geology*, v. 56, no. 2, p. 402-422, 10 figs., 2 tables, March-Apr. 1961, 14 refs.

The general geology of the Cerro de Pasco mine in central Peru is briefly reviewed to acquaint the reader with the setting of the large body of pyrite and associated ore bodies. The pyrite body is about 1 mi. long, up to 1/4 mi. wide, and extends downwards for more than 1/2 mi. Three main types of pyrite, namely "hard pyrite," "soft pyrite," and "pyrite breccia," probably represent the effect of replacement of different beds of limestone. Relict sedimentary structures show that the pyrite body is structurally controlled and that at least 90% of the body represents replaced sediments. The veins in the pyrite body and surrounding rocks probably belong to one period of deformation and seem to fit into a pattern of wrench fault tectonics. Supergene and hypogene Cu ore bodies in the pyrite body are localized by chemical, lithological, and structural factors.--Auth.

**3-2771.** Ohle, Ernest L. ORE DEPOSITS AND SEDIMENTARY FEATURES IN TENNESSEE: *Econ. Geology*, v. 56, no. 2, p. 444-446, March-Apr. 1961, ref.

Discussion of a paper by David L. Kendall (Geoscience Abstracts 2-3090). Four points are raised that do not support a syngenetic origin for Zn ores of the E. Tennessee district: 1) Age of the sand-filled vugs is critical. It seems no easier to make them primary sedimentary structures than later ones. More data are needed on the relative attitude of the sand laminations and the country rock bedding. 2) It is doubtful that extent and importance of reefs is sufficient to have caused Zn to precipitate from sea water. 3) Any theory of ore deposition should explain both the Tennessee ores and the fluorite and barite deposits at Sweetwater. Can algae precipitate barite and fluorite? 4) The sedimentary theory does not explain the fact that many E. Tennessee ore bodies are associated with arch and dome structures. --J. A. Chamberlain.

**3-2772.** Denisova, M. V. THE STAGES OF DEVELOPMENT OF COPPER-NICKEL MINERALIZATION IN THE NITTIS-KUMUZH'YE-TRAVYANAYA MASSIF: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 9, p. 15-21, 6 figs., pub. 1961, 4 refs.

New data were obtained recently on the formation of the Nittis-Kumuzhye Cu-Ni vein deposit in the Monche tundra. An analysis of the textural and structural features of the ores leads the author to the conclusion that 3 stages of mineralization can be identified: the magnetite, the pyrrhotite, and the chalcopyrite stages. --Auth.

**3-2773.** Black, P. T. TIN, TUNGSTEN, MOLYBDENUM MINERALIZATION, MOUNT PLEASANT AREA, NEW BRUNSWICK: Can. Mining Jour., v. 82, no. 4, p. 94-96, 2 illus., Apr. 1961.

Sn, W, and Mo mineralization occur in steeply dipping lodes near Mount Pleasant, 37 mi. S. of Fredericton. The lodes are in a silicified fissure volcanic vent which covers an area at least 6,000 ft. long and about 3,000 ft. wide.

Principal minerals are cassiterite, stannite, sphalerite, molybdenite, wolframite, chalcopryite, and galena. Associated minerals are pyrite, arsenopyrite, and fluorite. --W. C. Peters.

**3-2774.** Bhappu, Roshan B. ECONOMIC RECOVERY OF SELENIUM BY FLOTATION FROM SANDSTONE ORES OF NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Circ. 58, 41 p., 12 tables, 1961, 15 refs.

Investigation has shown that the Se-bearing sandstone ores from the Morrison and Galisteo formations of New Mexico are amenable to simple froth-flotation procedures. The common flotation reagents used are soda ash, sodium silicate, a neutral oil (kerosene), a xanthate, and a frother. Conditioning of the pulp prior to flotation plays an important role in the process, especially if the sandstone contains excessive amounts of silty clays and shales.

Under optimum conditions, the Se flotation is rapid and selective, Se recovery above 85% is possible, and an acceptable grade of concentrates above 4% is obtainable.

From the economic viewpoint, flotation recovery of Se appears attractive. The cutoff grades for the profitable recovery of Se as the major ore constituent are 0.12 and 0.04% for underground and open-pit mining operations respectively. On the other hand, when Se is recovered as a byproduct of some other

mining operation, such as mining for U, the cutoff grade is only 0.01%. --Auth.

**3-2775.** Abdel-Gawad, A. M., and Paul F. Kerr. URANO-ORGANIC MINERAL ASSOCIATION: Am. Mineralogist, v. 46, no. 3/4, p. 402-419, 5 figs., 3 tables, March-Apr. 1961, 29 refs.

Semi-fluid asphalt which percolates through U ore bodies on the San Rafael swell is indurated by heat at temperatures from 250°C.-300°C. The indurated material becomes brittle and generally similar in physical properties to naturally indurated "asphaltite." Infrared curves of artificially indurated material also compare favorably with curves for natural "asphaltite." Infrared curves for both indurated artificial and natural "asphaltite" show weak and indistinct absorption bands in contrast to the stronger absorption of semi-fluid asphalt.

Mineralogical investigation of the uranium silicate coffinite indicates that the mineral is similar to the synthetic coffinite, prepared by Fuchs and Hoekstra, through the absence of an essential hydroxyl component.

The intimate and widespread association of indurated U-bearing "asphaltite" and the uranium silicate coffinite suggests that the 2 were formed contemporaneously. The urano-organic constituent could presumably have been hardened by irradiation, although this seems unlikely. However, such an origin is hardly even conceivable for the uranium silicate coffinite. Hydrothermal origin is believed to prevail both for the coffinite and the associated uranium "asphaltite." --Auth.

**3-2776.** Rosholt, John N., Jr. LATE PLEISTOCENE AND RECENT ACCUMULATION OF URANIUM IN GROUND WATER SATURATED SANDSTONE DEPOSITS: Econ. Geology, v. 56, no. 2, p. 423-430, fig., 2 tables, March-Apr. 1961, 9 refs.

Pa-231 and Th-230 relations in several ground water saturated sandstones containing U ore indicate that much of the U has been accumulating in very recent times. Samples from the Hauber mine, Crook County, Wyoming, were selected to illustrate the concept of recent accumulation and the methods of calculation of the estimated minimum and maximum dates of the start of the U accumulation. The radiochemical results of 8 samples from this mine show extremely consistent radioactive daughter product distribution, and a close correlation between the estimated dates of the start of U accumulation and the U content of the ore. The results for mill pulp samples, representing large tonnages of ore, indicate that the major part of U deposition started between 40,000 and 130,000 years ago and the rate of deposition has increased approaching the present time. --Auth.

**3-2777.** Barrington, Jonathan, and Paul F. Kerr. URANIUM MINERALIZATION AT THE MIDNITE MINE, SPOKANE, WASHINGTON: Econ. Geology, v. 56, no. 2, p. 241-258, 9 figs., table, March-Apr. 1961, 34 refs.

The Midnight mine is located approximately 35 air mi. NW. of Spokane, Washington, near the confluence of the Columbia and Spokane rivers on the Spokane Indian Reservation. U mineralization occurs in a zone along the contact between the Cretaceous Loon Lake granite and Precambrian metasediments. Ores



appear to be found within and near associated fractures and shear zones. Secondary, oxidized U minerals, principally autunite and meta-autunite, lie above a fluctuating water table, while below this water table there occurs a zone of partially oxidized, lumpy and compact uraninite. Sulfide mineralization is associated with the uraninite.

Associated zones of argillic alteration that contain kaolinite, illite, montmorillonite, and intermingled adularia further indicate the action of hydrothermal solutions. Botryoidal masses of marcasite and shrinkage cracks in the uraninite imply colloidal precipitation in the formation of the primary U ore. Ore deposition is inferred to have taken place at temperatures on the order of 300°C. in a neutral or slightly acidic environment.--Auth.

3-2778. Sachs, Francis L., comp. RARE EARTHS AND MONAZITE SANDS; A LIST OF SELECTED REFERENCES TO TECHNICAL REPORTS, BOOKS AND JOURNALS: U. S. Atomic Energy Comm., [Pub.] TID-4900, 6 p., March 1961.

This list of 57 references includes technical reports prepared by the U. S. Atomic Energy Commission, its contractors, and other U. S. government agencies; also published literature (books, journal articles, etc.).--A. C. Sangree.

3-2779. Gindy, Amin R. RADIOACTIVITY IN MONAZITE, ZIRCON, AND "RADIOACTIVE BLACK" GRAINS IN BLACKSANDS OF ROSETTA, EGYPT: Econ. Geology, v. 56, no. 2, p. 436-441, 3 figs., table, March-Apr., 1961, 8 refs.

Rosetta monazite grains have an average radioactivity of about 3.4 alphas/cm<sup>2</sup>/sec., corresponding to about 6.5% eThO<sub>2</sub>. Individual grains are not equally radioactive, the range being from 2.720 to 14.087% eThO<sub>2</sub>. Zircon grains average 0.1087% eThO<sub>2</sub> and show considerable variation. "Radioactive black" grains are metamict and have a frequency occurrence of 0.8% of the monazite grains. Most of the "radioactive blacks" have activities in the range of 15 to 30 alphas/cm<sup>2</sup>/sec. Brief data on specific gravities, colors, and fluorescence are given.--J. A. Chamberlain.

3-2780. O'Rourke, J. E. PALEOZOIC BANDED IRON-FORMATIONS: Econ. Geology, v. 56, no. 2, p. 331-361, 12 figs., 3 tables, March-Apr. 1961, 75 refs.

Prospecting in the Nepal Himalaya has brought to light Fe-formations that are probably Paleozoic, and a search of the literature has revealed others. The generalization that all Fe-formations are Proterozoic or Archeozoic, which is a basic assumption in many theories, is very probably not valid, therefore. A class of Fe ores intermediate in lithology and age between the banded Fe-formations and the Clinton ores is described. A factor that may explain the distinctive features of banded Fe-formations while accounting for the absence of these features in the Clinton ores is discussed. The suggestion is made that sedimentary Fe ores show a progressive change in lithology with tectonic evolution.--Auth.

3-2781. Quirke, Terence T., Jr. GEOLOGY OF THE TEMISCAMIE IRON-FORMATION, LAKE ALBANEL IRON RANGE, MISTASSINI TERRITORY, QUEBEC, CANADA: Econ. Geology, v. 56, no. 2,

p. 299-320, 11 figs., 4 tables, March-Apr. 1961, 17 refs.

The Lake Albanel Fe range is located 400 mi. N. of Montreal, Quebec. Exploration has been conducted in the area for Fe ore since 1953. Sediments of the Precambrian Mistassini group, which include the Temiscamie Fe-formation, lie unconformably on older granites and on the SE. have been brought into juxtaposition with rocks of the Grenville metamorphic complex along the Mistassini fault (Grenville fault).

The Temiscamie Fe-formation has been divided into 6 members: lower argillite, lower sideritic chert, magnetitic chert, upper argillite, magnetitic iron-silicate and upper sideritic chert. These members are described in detail. Ten new chemical analyses of Fe-formation are presented.

The structure of much of the Fe-range is simple but increases in complexity near the Mistassini fault. In general the paragenesis of the minerals is simple. Siderite, chert, and hematite formed first along with, or shortly followed by stilpnomelane, minnesotaite, and octahedral magnetite.--Auth.

3-2782. Park, Charles F., Jr. A MAGNETITE "FLOW" IN NORTHERN CHILE: Econ. Geology, v. 56, no. 2, p. 431-436, 8 illus., map, March-Apr. 1961, 2 refs.

Unique magnetite-hematite deposits in the Laco area of northern Chile are believed to represent the crystallization of a recent "ore magma" composed almost entirely of iron oxides and abundant gas. The "ore magma" appears to have intruded tuff at shallow depth and in places to have broken out over the surface. Gas tubes, blisters, and ropy surfaces are common features.--J. A. Chamberlain.

3-2783. Serdyuchenko, D. P. THE ORIGIN OF THE ARCHEAN IRON ORES OF SOUTH YAKUTIYA: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 8, p. 28-41, 9 figs., pub. 1961, 36 refs.

A detailed description of the magnetite ore deposits enclosed in the Archean metamorphic strata of southern Yakutiya. The sedimentary origin of these Fe ore deposits is affirmed by the author. Some of the main features of these deposits are: the association of the magnetite deposits to a metamorphic sedimentary complex of rocks composed of different metamorphic gneisses, dolomites, schists, gneisso-quartzites and quartzites; a strict association of these deposits with a determined stratigraphic horizon - the Fedorovskaya suite of the Iengra series (Archean), tens of kilometers long and more than 1 km. thick; the faulting of the ore-bearing and other covering suites by granite intrusions, which occurred after the formation of the ore-bearing beds.

The study of core samples taken from rocks of the core samples taken from rocks of the Iengra series showed that there are 3 ore-bearing horizons, the upper a hematite-quartzite horizon, the middle magnetite-silicate horizon and the lower magnetite and hematite-quartzite horizon. The opinion of all geologists is that magnetite-quartzites and hematite-quartzites of Precambrian rocks all over the world are of sedimentary-metamorphic origin. The inference is that during the formation of ancient sediments of the Iengra series on the Aldan shield, the accumulation of Fe occurred under changing facies conditions. After the metamorphic period and after the granite intrusion these accumulations acquired the

presently observed composition. The author describes in detail all main commercial deposits of the lengra series, relating conditions at each to his main thesis. --From LC.

**3-2784. Bannatyne, Barry B. POTASH DEPOSITS, ROCK SALT, AND BRINES IN MANITOBA:** Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 59-1, 30 p., 8 figs., 2 tables, 1960, 25 refs.

In 2 parts: 1) Potash Deposits in Manitoba, and 2) Rock Salt and Brines in Manitoba. Potash deposits of economic importance have been outlined recently along the western boundary of Manitoba. Although K minerals were found in the province as early as 1951 in the Calstan Daly 15-18-10-27W well, it was not until exploration in Saskatchewan had revealed large potash deposits that serious exploration for potash was undertaken in the bordering part of Manitoba. The potash deposits occur in the Middle Devonian Prairie evaporite formation at depths in Manitoba ranging from 2,560 to more than 4,000 ft.

The deposits were formed by the precipitation of K salts from highly concentrated sea water within the Middle Devonian Elk Point basin. This basin extended about as far E. as the Virden area, and thus potash beds lie beneath a narrow crescent-shaped area along the S. part of the western boundary of Manitoba.

Because of the regional southwestward dip of the Prairie evaporite formation and the generally higher elevation of Saskatchewan, the potash deposit in Manitoba occurs a few hundred feet closer to the surface than most of the deposits in Saskatchewan. The main potash zone in Manitoba, consisting chiefly of halite and sylvite, ranges from 6 to 8 ft. thick, grades 25% K<sub>2</sub>O or better, and contains small amounts only of carnallite (KCl·MgCl<sub>2</sub>·6H<sub>2</sub>O) and clay. A salt bed 60 to 85 ft. thick covers the potash bed except along its subcrop belt; a substantial "salt back" is considered essential for the successful mining of potash beds. These factors makes the Manitoba potash deposit a potential commercial asset. --From introd., pt. 1, p. 3.

Common salt is produced either by evaporation of concentrated brines or from beds of rock salt. To date in Manitoba salt has been produced only by evaporation of brine.

Several flowing brine springs occur along the W. shore of Lake Winnipegosis. The largest springs are near Dawson Bay and flow out of the Middle Devonian Winnipegosis formation. The total maximum content of dissolved solids in these brines varies between 50,000 and 60,000 parts per million parts of solution (p.p.m.), too low for present day commercial production of salt. However, for many years prior to the completion of the railway from eastern Canada in 1881, up to 1,000 bushels of salt per year were produced by evaporation of these brines. A history of the early salt operations and a description of the brine springs are given by Cole and Cameron.

At present, salt is produced only by the Canadian Salt Company at Neepawa. The brines have been tapped at 2 horizons: the upper, at a depth of 1,160 ft., from a porous zone in the Souris River formation, and the lower, at a depth of 1,453 ft., from the Winnipegosis dolomite. The source formations have been determined by a comparison of the sample log of the Neepawa #2 well (9-33-14-15W) with the logs of neighboring wells. These brines have a total dissolved solid content of 170,000 to 180,000 p.p.m., of which NaCl forms more than 85%. The concentration has remained essentially constant from the time of first production in 1932 to the present. Production

now is about 23,000 tons of salt per year. The combined chlorides of Ca, Mg, and K, in dry form, are recovered as a by-product.

The only formation in Manitoba known to contain beds of rock salt is the Middle Devonian Prairie evaporite. Over 500 ft. of evaporites composed mainly of halite occur beneath the S. part of the Manitoba-Saskatchewan boundary, but the halite thins rapidly to the E. and none has been intersected E. of Oak Lake (township 8, range 24W). Potash minerals occur in the upper part of the halite. If the potash deposits are mined, it is possible that some rock salt will be produced as a by-product. In some parts of the world where subsurface beds of rock salt occur, artificial brines are made by introducing water into the salt beds and recovering the resulting brine. This process has not been tried in Manitoba. --From introd., pt. 2, p. 17.

**3-2785. Williamson, D. R. MEXICAN FLUORITE DEPOSITS:** Colorado School of Mines, Mineral Industries Bull., v. 4, no. 2, 15 p., 10 illus., map, table, March 1961, 3 refs.

The Mexican fluorite industry is based upon a large number of separate deposits in many small mines and a few sizeable operations. Areas are currently under development, and the potential is large.

A compendium on Mexican fluorite is given with notes based on observations by the author. The geology of the deposits is presented in relation to provinces, districts, and association with volcanism. Specific description is given for the following provinces: Encantada-Mariposa, La Paila-El Marte, San Luis-Rio Verde, Taxco, and Rio Grande. Comments are included on mining and milling. --W.C. Peters.

**3-2786. Harrison, Jack L. REFRACTORY CLAYS OF INDIANA:** Indiana Geol. Survey, Rept. Prog. no. 24, 18 p., fig., 7 tables, 1961.

Large reserves of clay suitable for low-duty refractory products are present in southwestern Indiana, as shown by PCE (pyrometric cone equivalent) determinations on a group of 310 samples. The great amount of refractory products used in Indiana would seem to warrant a larger output of refractories made from Indiana clays than the present output.

A tentative correlation of refractoriness and clay-mineral is based on results of mineralogic and particle-size determinations. --Auth.

**3-2787. Reed, Bruce. ORE DEPOSITS OF THE BANNOCKBURN BASIN, LARDEAU-AREA, BRITISH COLUMBIA:** Econ. Geology, v. 56, no. 2, p. 392-401, 5 figs., March-Apr. 1961, 3 refs.

The Bannockburn basin map-area in the Selkirk Mountains of southeastern British Columbia is underlain by Cambrian(?) metasediments. Two folds strike NW., a tightly folded and slightly overturned anticline and, on the NE., a longitudinally faulted syncline. Reverse faults, contemporaneous with folding, were followed by a major longitudinal fault and a series of cross faults.

A bed of porous quartzite in the Marsh Adams formation contains disseminated galena and minor sphalerite, forming a mineralized zone called the Shelagh vein, localized along the SW. limb and crest of the overturned anticline. The sequence of



minerals, from oldest to youngest, is pyrite, sphalerite, galena, and tetrahedrite.

Mineralization of the Wagner claims is localized along faults. The Bannockburn claims contain galena, with some sphalerite and chalcopyrite, localized as a saddle reef in the lower member of the Mohican formation.--Auth.

3-2788. Sutherland-Brown, Atholl. GEOLOGY AND SETTING OF MINERAL DEPOSITS OF THE QUEEN CHARLOTTE ISLANDS: Can. Mining Jour., v. 82, no. 4, p. 76-77, Apr. 1961.

The geology of the Queen Charlotte Islands is important to the understanding of the northern Pacific coast because the stratigraphy is typical but much better exposed than along most of the coast line.

A series of Triassic to Late Tertiary volcanics is predominant. Intervals of marine sediments are also present. A fault line scarp on the western coast of the islands is part of the circum-Pacific fault zone.

Pyrometamorphic magnetite and chalcopyrite bodies have been investigated. The most favorable deposits are on Tasu Sound and Harriet Harbour.--W. C. Peters.

3-2789. Barry, George S. MINERAL PROSPECTS AROUND GODS, ISLAND, AND OXFORD LAKES, MANITOBA: Can. Mining Jour., v. 82, no. 4, p. 61-65, map, Apr. 1961, 17 refs.

NE. of Lake Winnipeg, the Precambrian Superior province is the scene of large scale exploration for base metal sulfides. Important ore deposits are few in this region, but certain occurrences and structures look favorable. Ni prospecting in the vicinity of Island Lake is especially promising.

The region is dominantly granitic, with several well-defined greenstone belts comprising the Hayes River group and the Oxford, Cross Lake, and Island Lake series. Basic intrusives are related to the volcanic phases of the greenstones. The main belts appear to be remnants of synclines. Most sulfide occurrences are associated with shear zones paralleling the greenstones.

Recent aeromagnetic data should provide guides in projecting greenstone belts into new areas and beneath drift cover. Geological maps of some of the greenstone belts are now being prepared on a scale of 1 mi. to 1 in. by the Manitoba Dept. of Mines and Natural Resources.--W. C. Peters.

3-2790. Cheesman, R. L. GEOLOGICAL SURVEY WORK IN SASKATCHEWAN, 1960: Can. Mining Jour., v. 82, no. 4, p. 91-93, map, Apr. 1961.

A progress report is given for 8 geological parties placed in the field by the Saskatchewan Dept. of Mineral Resources during summer 1960. Areas newly mapped are: Attitti Lake, Settee Lake, Otter Lake, Deception Lake, Clut Lakes, Astrolabe Lake, Barnett Lake, and Thainka Lake.

A promising zone of Ni mineralization has been located in the Clut Lakes-Astrolabe Lake area. The nickeliferous pyrrhotite-chalcopyrite mineralization

is associated with a norite sill. A belt of Au mineralization has been traced northeasterly from La Ronge.--W. C. Peters.

3-2791. Crowley, Frank A. DIRECTORY OF KNOWN MINING ENTERPRISES, 1960: Montana, Bureau Mines & Geology, Bull. 20, 68 p., pl., 4 tables, 1961.

This report contains a list of the mining properties known to be active in Montana in 1960, giving the name, operator, owner, status, product, and location of each property; a list of active coal mines in Montana for 1960, submitted by Thomas Morgan, State Coal Mine Inspector; a section on the mineral industry of Montana, 1960, by F. B. Fulkerson, G. A. Kingston, and N. S. Peterson, U. S. Bureau of Mines.--Auth.

3-2792. Smirnov, V. I. THE DETERMINATION OF REGULAR PATTERNS IN THE DISTRIBUTION OF MINERAL DEPOSITS THROUGH THE U. S. S. R. - THE MOST IMPORTANT BRANCH OF GEOLOGIC STUDY: Akad. Nauk SSSR, Izvestiya, Geol. Ser., in translation, 1959, no. 9, p. 1-6, pub. 1961.

Additional proved reserves of minerals must be found and the recognition of patterns of distribution of ores is the most promising means of discovery. Principles laid down by earlier Soviet geologists are reviewed. Progress in prospecting maps for oil, gas, coal, and certain metals in various geologic institutes in the U. S. S. R. are described.--M. Russell.

3-2793. Woodtli, R. A. ECONOMIC DEVELOPMENT IN AFRICA AND ITS MINERAL RESOURCES: GeoTimes, v. 5, no. 8, p. 6-9, 42-43, 4 figs. incl. 2 maps, 2 tables, May-June 1961, 4 refs.

Africa's present economic significance and its potentialities for economic growth consist in a great measure in its mining production and in its mineral resources. For Africa as a whole, significant increases have occurred over the last twenty years in the production of Sb, asbestos, Cd, chromite, coal, Cu, diamonds, Au, Fe ores, Mn, Ni, phosphate rocks, Pt, Ag, and W. Africa also produces important quantities of minerals like beryl, Li, and U which had few uses before World War II.

Because of its underdeveloped industrial position, Africa remains a producer of raw materials for the rest of the world. It is far from having an industry on the scale of its population and its mineral resources. A greater rate of progress depends on more capital, more skill and experience, and on a rise in the productivity of man power.

Africa's unsettled political environment, racial tensions, and anti-Western independence are deterrent to the investment of capital in its mineral industries. To avoid economic crises and the ensuing political crises, multilateral agreements between raw material producers and consumer nations seem wise. Prices of minerals should be regulated at the same time as the level of their production.--G. L. Foster.

## 13. FUELS

See also: Geologic Maps 3-2490, 3-2492; Areal and Regional Geology 3-2500, 3-2511; Geomorphology 3-2533; Stratigraphy 3-2552, 3-2556; Geochemistry 3-2668, 3-2669, 3-2670; Mineralogy 3-2708; Engineering Geology 3-2811, 3-2818, 3-2819, 3-2831.

**3-2794. WILDCAT ODDS ARE GETTING TOUGH-ER:** Petroleum Week, v. 12, no. 13, p. 16, graph, March 31, 1961.

The odds against profitable wildcat discoveries are getting longer and longer with each year. The over-all discovery odds are still the same, 1 in 9. But the success ratio of profitable wells has lengthened from an average of 1 in 43 to 1 in 45. The most significant conclusion that can be made, however, is that 98% of all new-field wildcats are failures, in that they are eventually abandoned or discover reserves too small to be profitable, according to the Committee on Statistics of Exploration Drilling of the American Association of Petroleum Geologists.--C. C. McFall.

**3-2795. Jindra, Roy I. DEEP GAS SEARCH SPARKS TEXAS EXPLORATION:** World Oil, v. 151, no. 6, p. 97-100, Nov. 1960.

The deep Edwards and lower Wilcox plays are active from Lavaca County, Texas, to the Mexican border. The most active areas in the Railroad Commission District 1, are the Upper Cretaceous Navarro and Taylor sands in Dimmit and Maverick counties. Three important fields have been recently discovered in these counties.--Worldwide Oil & Gas Abstracts, v. 6, no. 1, p. 10, Jan.-Feb. 1961, abs. 61-8-11.

**3-2796. Nielsen, Hardy, ECONOMIC, PHYSICAL FACTORS AND THE ARCTIC FUTURE (CANADA):** Oil in Canada, v. 13, no. 16, p. 34-38, Feb. 23, 1961.

The definitive story of oil exploration and prospects in Canada's arctic regions. Legal, geological, thermal, topographic, logistic, and other considerations are presented.--Worldwide Oil & Gas Abstracts, v. 6, no. 2, p. 11, March-Apr. 1961, abs. 62-8-5.

**3-2797. Magas, I. O. GEOLOGY AND RESERVOIR CHARACTERISTICS OF THE GLEN EWEN FIELD, SASKATCHEWAN:** Saskatchewan, Dept. Mineral Resources, Rept. no. 48, 62 p., 21 figs., 11 tables, 1961, 30 refs.

The Glen Ewen field is located in the southeastern part of Saskatchewan on the northeastern flank of the Williston basin. The alternation of anhydrites and porous, permeable carbonates in the Mississippian succession, combined with an overlying unconformity, has resulted in structural-stratigraphic traps for oil in the Midale beds and in the upper part of the Frobisher-Alida beds below the post-Mississippian erosion surface.

The Midale beds pool was discovered in Jan. 1956, and to Dec. 31, 1959, had produced 770,205 barrels of oil. It is estimated that there were originally about 40,000,000 reservoir barrels of oil in place in the Midale beds reservoir and that the ultimate recovery by primary means will be 4,650,000 stock tank barrels.

The Frobisher-Alida beds pool was discovered in Aug. 1956, and to Dec. 31, 1959, had produced 96,473 barrels of oil. It is impossible at this time to predict the amount of oil in place in the Frobisher-Alida beds reservoir as there is a lack of drilling

in an area of the field which, from geological considerations, appears to be oil-bearing.

The need for great care in the selection of completion methods is pointed out, and it is suggested that more complete programs of logging, coring, and testing be undertaken in any new wells in order to determine the most advantageous zone in which to perforate. This and other factors, it is felt, have a very important bearing on the ultimate recovery of any well drilled in such a heterogeneous reservoir as the Glen Ewen field.--Auth.

**3-2798. OIL RESERVES UP 0.5%; FINDING RATE DROPPED IN 1960:** Petroleum Week, v. 12, no. 12, p. 11-14, 3 figs., 4 tables, March 24, 1961.

U. S. reserves of liquid hydrocarbons increased slightly last year to a new high of 38,429,270,000 barrels. But the net addition of 187,615,000 barrels was the smallest for any post-war year, except for a decline in reserves in 1957. Gross additions to liquid hydrocarbon reserves, amounting to 3,090,458,000 barrels, exceeded production in 1960 by a ratio of 1.06 barrel of reserves to 1 barrel produced.

A correlation of the reserves statistics with those for exploratory drilling show that 1960 was the worst year for exploration in the post-war period, with the indicated oil-finding rate dropping to 11.4 barrels per foot drilled. Along with the slight increase in reserves last year, total exploratory drilling in the U. S. declined noticeably - off 11.7% in footage and 11.2% in the number of tests drilled.

No major field - one with ultimate reserves of 50-million barrels or more - was discovered last year. The last year of such a major discovery was 1954 with 2 class "A" fields.--C. C. McFall.

**3-2799. Wadsworth, Albert H., Jr. HOW LOWER FRIO CHANGES IN DEPTH:** World Oil, v. 151, no. 6, p. 123-124, 126, Nov. 1960.

Previous mapping of Gulf Coast lower Frio strata [Tertiary] is only partially correct. Buried fault blocks with reverse dip, structural shifts with depth, and areas of slumpage are critical to drilling plans.--Worldwide Oil & Gas Abstracts, v. 6, no. 1, p. 9, Jan.-Feb. 1961, abs. 61-7-13.

**3-2800. Bado, John T. NORTH OKARCHE FIELD, KINGFISHER COUNTY, OKLAHOMA:** Oklahoma Geology Notes, v. 21, no. 4, p. 113-117, 2 figs., table, Apr. 1961.

This field, 3 mi. SW. of Kingfisher and 1 mi. N. of Okarche, is one of the numerous stratigraphic-type oil and gas fields now being discovered and developed in Oklahoma.

Production is found in the Manning zone, a reservoir in the lower part of the Chester series (Late Mississippian). The Manning consists of an upper sandstone, ranging from 35 to 50 ft. in thickness, and a lower limestone, 20 to 25 ft. thick.

Depth to the producing zone ranges from 7,780 to 8,240 ft. Calculated open-flow production of individual wells ranges from 3,758 to 17,500 MCFG/D (million cubic feet of gas per day).--Auth.

**3-2801. Reeves, Corwin C., Jr., and W. F. Brazelton. THE STOCKTON FIELD - KEY TO THE MARIETTA BASIN?:** Oklahoma Geology Notes, v. 21, no. 4, p. 118-127, 7 figs., Apr. 1961.



The Marietta basin, one of the smaller structural features of S.-central Oklahoma, is surrounded by many prolific oil fields. Unfortunately, after a 36-year exploratory program, the basin can boast of only a few small oil fields; however, several recent discoveries have once more attracted exploratory interests.

The Stockton field, discovered in 1936, produces from Deese sands. Trapping results from Pennsylvanian closure over the basin's main NW.-SE.-trending pre-Pennsylvanian anticline.

Although no post-Simpson, pre-Pennsylvanian rocks are present on the crest of the Stockton structure, the stratigraphic sequence can be correlated with numerous producing areas along both flanks. Obviously geologic study of the Stockton field, one of the few producing areas of the Marietta basin, directs attention to like areas and horizons best suited for future exploratory attempts.--C. C. Reeves.

**3-2802. CLUSTER OF OIL FINDS IS OUTLINED IN NEW MIDEAST AREA:** *Petroleum Week*, v. 12, no. 16, p. 80, 81, map, Apr. 21, 1961.

The Middle East's newest oil province may be taking shape at the southern end of the Persian Gulf. Oil has been found now in 3 separate areas - one onshore SE. of Qatar, the others offshore E. of Qatar. Delineation drilling under way at Murban, in Abu Dhabi, has apparently confirmed discovery of the first onshore field in the southeastern end of the Arabian peninsula.

Some 60 mi. offshore, in Abu Dhabi's waters, a fifth test is being drilled in the Umm Shaif field, which is slated to be put into production next year. On an adjoining offshore concession E. of Qatar, Shell is drilling a fourth test at Idd el Shargi to evaluate the potential of oil encountered in 2 of 3

tests it has drilled on the structure so far.--C. C. McFall.

**3-2803. Westgate, R. RED CHINA CLAIMS LARGE OIL RESOURCES ARE BEING DEVELOPED:** *World Oil*, v. 151, no. 6, p. 138-158 passim, Nov. 1960.

China has a minimum potential capacity of over 2 million barrels of petroleum per day. Oil-bearing structures have been found in one quarter of the country's land area. Lenghu is now the key prospecting area in the Tsaidam basin. Here 10,000 workers are sinking test wells and recovering oil. To date there are 4 known great oil fields in China.--*Worldwide Oil & Gas Abstracts*, v. 6, no. 1, p. 10, Jan.-Feb. 1961, abs. 61-8-12.

**3-2804. Bingham, Les. BROWN COAL WEALTH OF VICTORIA'S LATROBE VALLEY:** *Can. Mining Jour.*, v. 82, no. 3, p. 84-86, illus., March 1961.

Proven brown coal reserves in the Latrobe Valley, Victoria, Australia, total 20,000 million tons; additional reserves are expected as exploratory work proceeds. Drilling at one point has revealed the thickest known seam of coal in the world, 757 ft. thick at a depth of 89 ft. below the surface. From Yallourn, the center of operations, the coal belt is practically continuous for 40 mi. and for much of the distance is between 4 and 10 mi. in width.

The coal is free from S, has a constant calorific value, and is almost completely free from stone.

Yallourn, 90 mi. from Melbourne, is the site of a large power station and a 600,000 ton-per-year briquette factory. Morwell, a few miles distant, has a briquette factory and a 15 million cu. ft.-per-day gasification plant.--W. C. Peters.

## 14. ENGINEERING GEOLOGY

See also: Stratigraphy 3-2558.

**3-2805. Blystone, Jerome R., and others. MOISTURE CONTENT DETERMINATION BY THE CALCIUM CARBIDE GAS PRESSURE METHOD:** *Public Roads*, v. 31, no. 8, p. 177-181, 4 figs., 2 tables, June 1961, ref. (not seen at AGI).

A rapid and accurate method of determining soil moisture in the field with simple portable apparatus is an important need in engineering. A promising device developed in England measures moisture content indirectly by gaging the pressure of gas generated when calcium carbide reacts with the moisture in a small soil sample. This article reports the results of tests on 11 soils, ranging from group A-2-4(0) to group A-7-5(20) (essentially silty sand to elastic clay and ranging from excellent to very poor as subgrade materials). The tests lead to the conclusion that the method is dependable, reasonably accurate, and fast and easy to operate. It is well suited for field control of materials and construction practices and as a quick check of other field laboratory tests that involve moisture determinations.--E. B. Eckel.

**3-2806. Scheidegger, Adrian E. and E. F. Johnson. THE STATISTICAL BEHAVIOR OF INSTABILITIES IN DISPLACEMENT PROCESSES IN POROUS MEDIA:** *Can. Jour. Physics*, v. 39, no. 2, 7 figs., Feb. 1961,

7 refs.

The problem of growth of instabilities (fingers) in displacement processes in porous media is analyzed from a statistical viewpoint. The relative area occupied by fingers is represented as a "saturation," and the equations of motion for this "saturation" are derived. It is shown that these equations are analogous to the Buckley-Leverett equations of immiscible displacement, with a fictitious "relative permeability" being introduced. The latter can be calculated, and thus the statistical equations of motion of a fingered-out front can be written down explicitly. These equations of motion can then be solved by the well-known method of characteristics. It is shown that the statistical theory does not lead to any stabilization of the fingers.--Auth.

**3-2807. California, University, Radiation Laboratory, Livermore. PHYSICAL PROPERTIES OF SALT SAMPLES. FINAL REPORT.** By Raymond S. Guido and Stanley E. Warner: U. S. Atomic Energy Comm., [Pub.] UCRL-6069, 14 p., July 1960 (not seen at AGI).

The purpose of Project Cowboy was to investigate the seismic signals generated by chemical explosions in underground cavities, with particular emphasis on the possibility of decoupling of the signals from the surface surrounding media. Results of physical and

chemical tests performed on salt samples taken from the Carey Salt Company salt mine are reported. --W. L. H. (courtesy Nuclear Science Abstracts, v. 15, no. 1, p. 53, abs. 385, Jan. 15, 1961).

**3-2808.** McKeown, Francis A., and Dayton D. Dickey. INTERIM REPORT ON GEOLOGIC INVESTIGATIONS OF THE U12e TUNNEL SYSTEM, NEVADA TEST SITE, NYE COUNTY, NEVADA: U.S. Geol. Survey, Trace Elements Inv. Rept. 772, 17 p., 8 figs. (in pocket), 6 tables, Sept. 1960, 6 refs.

The maps and tables composing this report provide a summary of the geology of the U12e tunnel system, Nevada Test Site. The parts of the U12e tunnel system described consist of a 5,700-ft. main tunnel, U12e, and 5 lateral tunnels, U12e.01, U12e.02, U12e.03, U12e.04, and U12e.05, totalling about 8,900 ft., into the E. side of Rainier Mesa. The U12e.02 and U12e.05 tunnels were the sites of the nuclear tests code named Logan and Blanca that were conducted in Oct. 1958.

The U12e tunnel system penetrates tuffaceous rocks in the lower 800 ft. of the Oak Spring formation of Miocene(?) or younger age. The Oak Spring formation was divided into 8 lithologic units, listed in ascending order Tos<sub>1</sub> through Tos<sub>8</sub>. Rock units mapped in the U12e tunnel system are in the lower 4 units (Tos<sub>1</sub> through Tos<sub>4</sub>) of Hansen and Lemke. The most significant structural element mapped in the U12e tunnel system is a broad syncline that plunges about 2° SW. Minor anticlines and synclines with amplitudes of 10 to 30 ft. occur on the limbs of the broad syncline. The maximum dip of the beds is 14°. Joint diagrams graphically summarize the attitudes of all joints in selected parts of the tunnel system.

The description of samples collected for other than physical property determinations from the U12e tunnel system, exclusive of the U12e.02 and U12e.05 tunnels, and the results of analyses of the samples are given. The analytical data indicate that the variation in oxide and minor element content of the tuff exposed in the U12e tunnel system is small; the significance of the small variations is unknown. --M. Russell.

**3-2809.** MONTE BIANCO TUNNELERS NEAR TWO-MILE MARK: World Construction, v. 14, no. 4, p. 20-22, 6 illus., Apr. 1961, ref.

The 7-mi. Monte Bianco tunnel, between Courmayeur, Italy, and Chamonix, France, will save from 100 to 200 mi. travel between Milan and Paris. It is being driven from both portals with an excavated section of 925 sq. ft. Work on the Italian end has advanced to 8,250 ft. and has been marked by many difficulties. The first 4,270 ft. are in Liassic calcareous schists. The remainder is in pseudostratified granite. At 1,207 ft. water flooded the heading. At 1,644 ft. unstable rock conditions caused a heavy fall and necessitated changing from full face to the top heading tunneling method. At 2,625 ft. the schists became extremely soft and hazardous to drill and blast. A pilot tunnel, driven in advance of the top heading by pick and shovel, required heavy timbering. These sections were later excavated to full face. At 4,270 ft. the pseudostratified granite allowed a resumption of the full face tunneling method, but at 4,593 ft. rock bursts had to be contained by roof bolts. As tunneling proceeded the rock bursts became more frequent and required the addition of steel netting tied into the roof bolts. At

6,890 ft. the rock bursts became so frequent that a 161-sq.-ft. pilot tunnel was driven ahead of the full section to reduce the rock stress at the face. Work on the French side has advanced to 6,562 ft. with fewer difficulties. --R. Van Horn.

**3-2810.** Cederstrom, D. John, and G. C. Tibbitts, Jr. JET DRILLING IN THE FAIRBANKS AREA, ALASKA: U.S. Geol. Survey, Water-Supply Paper 1539-B, 28 p., 8 figs., 1961, 9 refs.

The report describes the construction and operation of an experimental jet-drilling machine in the submontane area N. of Fairbanks, Alaska. The drilling, conducted during a 2-month period in the summer of 1954, penetrated the Birch Creek schist and the sand-, silt-, and gravel-filled old subordinate valleys. Some of the silt has a high organic content and is called muck. Some of the muck was permanently frozen. Silt and muck were drilled rapidly, and required as little as 1 1/2 min. per ft. including time for changing rods, whereas drilling time in hard-packed sand and in schist averaged about 15 to 20 min. per ft. Frozen muck required about 3 min. drilling time per foot. It is concluded that the method is a practical and economical one for use in the area in which it was tried, and it could be used with reasonable success in other alluvial areas where boulders are uncommon.

The equipment consisted of a double-acting piston pump capable of furnishing fluid at a pressure of 1000 p.s.i., a 7- to 8-h.p. type Z single-cylinder engine, and a derrick. A reciprocating motion was provided by a crank that operated a centrally pivoted beam. The drill rods were 1-in. extra heavy pipe. Z-bits and chisel bits were used. Operation of the rig, difficulties encountered, and suggestions for avoiding time-consuming trouble are discussed.

The usefulness of the method for general earth testing is mentioned, and suggestions are made for jet drilling on a production basis. --Auth.

**3-2811.** Jordan, Louise. UNDERGROUND LPG STORAGE IN OKLAHOMA: Oklahoma Geology Notes, v. 21, no. 3, p. 95-96, 2 tables, March 1961, 4 refs.

Propane is stored at 4 facilities in Oklahoma in 3 types of underground caverns: salt layers, mined shale and limestone, and abandoned oil wells. Storage capacity at the end of 1961 will amount to 633,000 barrels. This includes the estimated 175,000-barrel capacity of 2 abandoned wells in the Fitts Field, Pontotoc County, one of which was converted to a water-disposal well in 1960. Tabulation of injections and withdrawals from the 2 wells show that less than 50% of the injected LPG [liquefied petroleum gas] was recovered from the well converted to water disposal. --Auth.

**3-2812.** GRADING METHODS FOR PITTSBURGH'S NEW RUNWAY: World Construction, v. 14, no. 4, p. 28-31, 36, 37, 11 illus., map, 3 secs., Apr. 1961.

The largest volume of earthwork ever to be required for a single runway system - at least in U.S. peace-time annals - was moved to construct the new 3 mi. E.-W. runway at Pittsburgh, Pennsylvania. The contract work required making cuts up to 80 ft. deep and embankments up to 90 ft. high, relocation of local roads, building concrete creek enclosures, plugging active oil wells, sealing off old coal mines, and excavating and backfilling coal seams. Soil in-



cluded loam, yellow clay, and blue slaty material. The rock included limestone, sandstone, shale, mudstone, and coal. The planning and scheduling of the order of construction was obtained from drill-hole data and maps drawn from aerial photographs.--Van Horn.

**3-2813. Mullins, Lawrence E. TERRAIN ANALYSIS FOR CROSS-COUNTRY MOVEMENT: Military Engineer, v. 53, no. 351, p. 35-36, illus., Jan.-Feb. 1961, 4 refs.**

The primary terrain factors limiting cross-country movement are topography, soils, and vegetation. Slopes more than 45% are considered impassable, between 25% and 45% as impediments to movement. Soils are separated into categories to reflect movement possibilities with varying moisture content. Actual passage of vehicles, instruments such as the cone penetrometer, and laboratory analyses are used. Vegetation analysis includes the types, sizes, and densities of trees. Vegetation characteristics may be obtained by stereoscopic study of aerial photographs, supported by field checking. The classifications as each affects movement are combined to compile cross-country movement maps.--A. C. Mason.

**3-2814. Duffell, Stanley. "ROADS TO RESOURCES" WESTERN ONTARIO PROJECT: Can. Mining Jour., v. 82, no. 4, p. 77-79, Apr. 1961.**

A cooperative project covering some 60,000 sq. mi. in northwestern Ontario has been undertaken by the provincial and federal governments to provide geological and geophysical information for location of a road system into the northern parts of the country.

The first phase of the project, an aeromagnetic survey involving 160 maps on a scale of 1 mi. to 1 in. has been completed. Ground surveys are being continued with supporting geochemical investigations. Geological interpretation of geophysical anomalies has led to the modification of known belts of greenstone and to the discovery of new belts.

Bedrock mapping has been completed for the Trout Lake, Lake St. Joseph, North Spirit Lake, North Caribou Lake, and Miminiska areas.--W. C. Peters.

**3-2815. Ives, J. D. A PILOT PROJECT FOR PERMAFROST INVESTIGATIONS IN CENTRAL LABRADOR-UNGAVA: Canada, Dept. Mines & Tech. Surveys, Geog. Branch, Geog. Paper no. 28, 26 p., 16 figs., 1961, 13 refs.**

This paper discusses practical difficulties encountered during permafrost investigations in the vicinity of Schefferville, central Labrador-Ungava. The importance of a research program into problems of Fe-ore mining in permafrost areas is considered.--F. A. Cook.

**3-2816. Gribble, William C., Jr. FOUNDATIONS IN PERMAFROST: Military Engineer, v. 52, no. 350, p. 445-447, 11 figs., Nov.-Dec. 1960, ref.**

Three types of foundations adapted to permafrost have been used in military installations at Bethel, Alaska, situated on the Kuskokwim delta facing Bering Sea. For a heavy installation, auger holes were bored through 10 ft. of active zone into 20 ft. of permafrost, refrigerated piles were placed in them,

and backfill slurry was frozen by refrigerant circulating through tubing. At a communication site, a protective blanket was placed over construction area, shallow auger holes were filled with a mixture of bentonite and sand to keep water away; and piling was driven to refusal in permafrost; if this occurred short of specified penetration an oil-wax mixture was placed around the top of the pile to reduce frost adhesion and heave on the pile. Support for the light load of an operations building was obtained by a spread footing with top at elevation of permafrost surface, the excavating and backfilling being done quickly to prevent degradation of the permafrost below the bottom of the footing.--A. C. Mason.

**3-2817. THE FAILURE OF THE MALPASSET DAM: Am. Engineer, v. 30, no. 11, p. 35, Nov. 1960 (not seen at AGI).**

Failure of the Malpasset dam on the Reyran River near Frejus, France, on Dec. 3, 1959, has been attributed to rock (type or kind not specified) failure below the foundation of the dam. An investigating commission made exhaustive studies as to the cause of failure, and the conclusion reached indicated weaknesses in the foundation rock led to the destruction of the dam.--R. M. Allen, Jr.

**3-2818. Nelson, A. SOME GEOLOGICAL ASPECTS OF MINING ENGINEERING: Can. Mining Jour., v. 82, no. 3, p. 62-66, 3 illus., March 1961, 5 refs.**

Geological factors in selecting mine locations are reviewed with examples from the coalfields of Great Britain.

Shaft problems involve water-bearing structures, unstable ground, and tributary mine development conditions, the objective being to design shafts which will remain secure, dry, and undisturbed.

Mine site investigations, making use of boreholes and geophysical data, furnish useful information on soils, superficial deposits, and underlying rock formations. Where large buildings are planned, shear strength and compressibility tests are advised, with subsequent consideration given to the use of reinforced concrete piles and soil stabilization methods. For investigating the stability of earth slopes at the mine site, useful instruments include the vane and the penetrometer.

Subsidence hazards need to be reviewed at frequent stages during mine development.

Faulting structures of importance include those which control waterlogged areas and those which remove large acreages of coal from use.--W. C. Peters.

**3-2819. Jones, Paul H., and V. Subramanyam. GROUND-WATER CONTROL IN THE NEYVELI LIGNITE FIELD, SOUTH ARCOT DISTRICT, MADRAS STATE, INDIA: Econ. Geology, v. 56, no. 2, p. 273-298, 14 figs., 2 tables, March-Apr. 1961, 12 refs.**

Unconsolidated deposits of the Cuddalore series of Miocene age underlie much of the coastal plain of southern Madras. Several lignite seams occur in a thick sequence of sand, gravel, and clay that dips seaward about 40 to 100 ft. per mi. The principal seam of lignite mapped in the Neyveli area averages more than 50 ft. in thickness, underlies at least 80 sq. mi., and occurs at a minimum depth of 165 ft. near Neyveli, where deposits totalling 230 million tons have been proved in an area of 4 1/2 sq. mi.

The lignite seam is immediately underlain,

throughout its area of occurrence, by a thick bed of sand and gravel that contains artesian water, the head of which is more than 100 ft. above the top of the lignite at Neyveli. The sand and gravel aquifer is exposed to recharge in and near its outcrop area, 6 to 10 mi. NW. of Neyveli, where the average annual rainfall is 41 in.

Hydraulic tests of the aquifer indicate that groundwater control for mining by opencast from a pit 6,000 ft. long and 1,200 ft. wide will require continuous withdrawal of about 40,000 gallons (Imperial) per minute from wells in and adjacent to the mine. The well field, including 50 to 65 large-capacity wells, must move with the open cut; and no appreciable decrease in the withdrawal rate can be expected throughout the life of the mine, which is designed to produce about 3 1/2 million tons of raw lignite per year.--Auth.

**3-2820.** Leonov, Mikhail. SOVIET PEOPLE TO ALTER THE COURSE OF NORTHERN RIVERS: Soviet Union Today, no. 6(76), p. 24-25, fig., June 1961 (not seen at AGI).

Popular description of the plan to divert the headwaters of the N.-flowing Pechora and Vychegda rivers into the headwaters of the S.-flowing Kama river, a tributary of the Volga river which in turn flows into the Caspian Sea. Three dams (the largest, 10 mi. long and as high as a 25-story building) and 2 canals (the longest, 90 mi.) will form the world's largest man-made lake in the upper reaches of the 3 drainage basins. The southward-diverted water will permit the annual production of an additional 11,000 million kwh. of hydroelectricity in the Volga basin, help by irrigation the alleviation of the drought conditions of 20 of the last 65 years in the lower Volga lands, provide a direct inland waterway from the southern seas to the Arctic Ocean, and first stabilize and then raise the level of the Caspian Sea, which has fallen about 2 m. in the last 3 decades. Engineers estimate that the project will involve the cutting and filling of about 700 million cu. yds. of material.--R. S. Taylor.

**3-2821.** Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. DISPOSAL OF RADIOACTIVE WASTES: PROCEEDINGS: v. 2, 581 p., Vienna, International Atomic Energy Agency, 1960 (not seen at AGI).

The proceedings are divided into areas of discussion on biological aspects of disposal at sea; physical and chemical aspects of disposal at sea; advantages and disadvantages of disposal at sea; research required for safe disposal at sea; considerations on waste disposal to the ground; and advantages and disadvantages of disposal in geological structures. Included in the proceedings are abstracts of the individual papers in English, French, Russian, and Spanish. For the papers given in French and Russian, English translations are included. B. O. G. (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 479-480, abs. 3736, Feb. 15, 1961).

**3-2822.** Merritt, W. F., and P. J. Parsons. SAMPLING DEVICES FOR WATER AND SOIL (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ... Proceedings: v. 2, p. 329-338, Vienna, 1960)

Movement of radioactivity below ground is monitored at Chalk River, Ontario, by several methods. Sealed Al pipes are set in the ground down to the gla-

cial till. A battery-operated Geiger counter is lowered down the pipe on a cable. It can detect activity of 20 to 50 d.p.m./ml. dissolved in ground water. A portable  $\gamma$ -ray spectrometer is being developed for use in these dry wells. Ground water is sampled at fixed depths by Alundum thimbles connected to the surface by polythene tubing. Samples are withdrawn into an evacuated flask. Several thimbles can be taped to a rod that is positioned inside a casing driven to the required depth; the casing is then withdrawn, leaving the thimbles in position in the soil. Porous bronze piezometers can be pressed or driven to any depth in the absence of rock. Water passes freely through the bronze and is withdrawn into an evacuated flask. Multiple samples of soil may be taken at a series of preselected depths in one hole by samplers set inside connected section of drill rod. Each sampler is a hollow rod pierced by slits which are closed during drilling by a piston. For sampling, the piston is slightly withdrawn and the rod twisted. A second piston, attached to the first, is then drawn up to close the slots, and the string of samplers is lifted from the hole. Undisturbed samples of sand are taken below the water table by a sampler containing an air bell which enables the sample to be withdrawn into an air cavity and be held in the tube by air pressure while the sampler is being brought to the surface.--Auth. (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 484, abs. 3759, Feb. 15, 1961).

**3-2823.** Pearce, D. W., and others. A REVIEW OF RADIOACTIVE WASTE DISPOSAL TO THE GROUND AT HANFORD (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ... Proceedings: v. 2, p. 345-363, Vienna, 1960)

The disposal of radioactive wastes to the ground from the Hanford [Washington] separations plants is summarized; volumes of wastes and contained curies discharged to swamps, trenches, and cribs are presented. Significant literature on ion-exchange studies using Hanford soils is reviewed. A field experiment with a model crib is described; preliminary findings indicate that spreading a waste solution below a disposal facility may be of greater benefit in disposal operations than previously assumed. Further studies with the calcite-phosphate reaction are reported; significant variables which affect  $\text{Sr}^{2+}$  removal are calcite surface area, pH of the influent, flow rate, temperature, and phosphate ion concentration. Bone-seeking radioisotopes are also removed from  $\text{F}^-$  solutions when contact is made with calcite. The zeolite clinoptilolite shows high selectivity for  $\text{Cs}^+$  even in the presence of increased  $\text{Na}^+$  concentration. The effect of the large-scale ground disposal operation at Hanford is described by means of a map and geological cross sections showing areas and volumes of ground and ground-water contamination.--Auth (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 484, abs. 3760, Feb. 15, 1961).

**3-2824.** Parker, Frank L., and others. DISPOSAL OF RADIOACTIVE WASTES IN NATURAL SALT (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ... Proceedings: v. 2, p. 365-384, Vienna, 1960).

The proposed use of cavities in salt formations as a disposal site for radioactive wastes is based upon 1) existence of salt for geologic time periods; 2) the impermeability of salt to the passage of water; 3) the widespread geographical distribution of salt; 4) the



extremely large quantities of salt available; 5) the structural strength of salt; 6) the relatively high thermal conductivity of salt in comparison with other general geologic formations; 7) the possible recovery of valuable fission products in the wastes injected into the salt; 8) the relative ease of forming cavities in salt by mining, and the even greater ease and low cost of developing solution cavities in salt; and 9) the low seismicity in the areas of major salt deposits. Radioactive liquid wastes can be stored in cavities in natural salt formations if the structural properties of the salt are not adversely affected by chemical interaction, pressure, temperature, and radiation. Analytical studies show that it is possible to store 2-year-old 10,000 Mwd./ton, 800 gal./ton, waste in a sphere of 10 ft. diameter without exceeding a temperature of 200°F. Laboratory tests show that the structural properties and thermal conductivity of rock salt are not greatly altered by high radiation doses, although high temperatures increase the creep rate for both irradiated and unirradiated samples. Chemical interaction of liquid wastes with salt produces chlorine and other chlorine compound gases, but the volumes are not excessive. The migration of nuclides through the salt and deformation of the cavity and chamber can only be studied in undisturbed salt *in situ*. One-fifth-scale models have been run in a bedded salt deposit in Hutchinson, Kansas, and full-scale field tests are in progress.--Auth. (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 485, abs. 3761, Feb. 15, 1961).

3-2825. Honstead, J. F. MOVEMENT OF RADIOACTIVE EFFLUENTS IN NATURAL WATERS AT HANFORD (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ...Proceedings: v. 2, p. 385-399, Vienna, 1960)

The Hanford [Washington] plant is located in a semiarid region on a very thick bed of unconsolidated water-deposited sediments resting on the basalt bedrock. This material may be considered in 2 geologic units, the lower bed being much less permeable than the upper. The Columbia River flows through the plant area, and it is first used for human consumption about 55 km. down-stream from the last reactor plant. Low-level effluent from the reactors is discharged into the Columbia River after a 1 to 3 hour holdup period in retention basins. More than 60 radioisotopes were identified in the effluent, nearly all of very short half-life. Depletion of various radioisotopes in river water by mechanisms other than decay is observed. This averages about 40% in the 55 km. between the reactors and Pasco and is ascribed to biological assimilation and sedimentation processes. Low-level waste solutions from chemical processing plants are discharged into the ground where they seep through 70 to 120 m. of sediments before reaching the local water table. Most of the radioactive material is immobilized by adsorption or other reactions during passage through the soil. The water and the few contaminants that reach the water table move with the ground water toward the Columbia River. The rate and direction of travel are determined by the form of the water-table surface and the hydraulic characteristics of the transmitting aquifers. The local water-table configuration was radically affected by the disposal of large volumes of water. From the gradient and the measured permeabilities of the aquifers an average "travel time" for water of 180 years is estimated. It is recognized that the maximum velocity may be several times the average. The effect of adsorption or other reactions is greatly

to slow down the movement of dissolved material relative to the rate of movement of the water. No movement of fission products from the disposal sites to the river was detected.--Auth. (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 484-485, abs. 3762, Feb. 15, 1961).

3-2826. Struxness, E. G., and others. WASTE DISPOSAL RESEARCH AND DEVELOPMENT IN THE UNITED STATES OF AMERICA (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ...Proceedings: v. 2, p. 481-498, Vienna, 1960)

A review of the waste disposal research and development carried out in the United States is given. The major research effort concerns the conversion of high-level liquid wastes into solids. At Hanford [Washington] and Oak Ridge [Tennessee] low-level wastes are disposed to the ground in pits, cribs, and lagoons. Geochemical studies related to waste disposal are conducted at Hanford, Oak Ridge, and the University of North Carolina. Experiments with soil columns are described; these are more effective for the decontamination of waste streams than either cribs or pits. The most suitable exchange materials for the soil columns are found to be vermiculite supported by rock phosphate and the latter supported by graded gravel. The progress of research work on the possibility of injecting radioactive liquid wastes into porous formations through deep wells and disposing of radioactive wastes in impermeable formations by hydraulic fracturing is outlined.--Auth. (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 485-486, abs. 3767, Feb. 15, 1961).

3-2827. Brown, Randall E. DESIRABLE NEW GEOLOGIC RESEARCH IN SUPPORT OF RADIOACTIVE WASTE DISPOSAL AS INDICATED BY HANFORD EXPERIENCE (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ...Proceedings: v. 2, p. 499-516, Vienna, 1960)

All disposal of radioactive wastes to land relies on the geologic environment. Disposal to that environment is not ultimate, since no material is impermeable, unleachable, or noncorrodible when geologic time is considered. Hanford's disposal intersects a maximum of geologic features between disposal sites and the point of nearest public exposure. This is the "delay-and-decay" concept named by Simpson. Problems involved in disposal at Hanford include 1) the quantitative inexactness of geology, 2) the lack of isotropic homogeneous earth materials, 3) determination of the quantitative importance of deviation of geologic and hydrologic features from an average, and 4) determination and measurement of the parameters of interest. Cases at Hanford are cited to illustrate these points. Wells totaling 557 in number and 33,000 m. in depth were drilled, but provide data that must be cautiously used. Standard aquifer performance tests are limited in value, since unit and directional permeabilities are integrated into average values. Ion-exchange studies provide quantitative values of direct interest, helping to interpret geologic features. Hydrologic studies, correlated to the soil chemistry work and the geologic data, result in logically explainable geologic controls to ground-water movement. Disposal to ground of radioactive wastes is neither a cure-all nor something to be feared. The integration of data from studies by geologists, hydrologists, geochemists, and mathematicians has gone far to assure the safe disposal of wastes to ground at Hanford. A great amount of work remains to be

done.--Auth. (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 486, abs. 3768, Feb. 15, 1961).

**3-2828.** Simpson, Eugene S. SUMMARY OF CURRENT GEOLOGICAL RESEARCH IN THE UNITED STATES OF AMERICA PERTINENT TO RADIOACTIVE WASTE DISPOSAL ON LAND (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ... Proceedings: v. 2, p. 517-531, Vienna, 1960)

Research in geology may be divided into 3 categories according to the degree of containment required for the waste in order to assure conformance with generally accepted standards of health and safety. 1) Maximum containment environments are intended to retain for centuries or for millennia essentially all waste materials stored in them. Two general types are under investigation, salt deposits and deep permeable formations. In both cases various laboratory experiments are being performed to study the interaction between waste solutions and appropriate earth materials, and, in the case of salt, a field experiment is in progress utilizing simulated (nonradioactive) high-activity waste. 2) Intermediate containment environments are intended to slow down significantly the mobility of radioactive wastes to provide sufficient time for radioactive decay before the wastes come into contact with man or his food chain. Examples of intermediate containment are shallow burial of packaged waste and discharge of bulk liquid waste into seepage pits. Research is in progress to study the combined effect of transport of radionuclides by ground water and retention of radionuclides by sorption on earth materials. 3) Environments of no containment are those in which radionuclides are immediately brought into contact with man or with any of the biota of his food chain. Research is under way both to determine the capacity of individual environments to receive such waste within health and safety limits and to improve techniques for doing so. Current research includes a) classification of terrains as related to waste disposal problems, b) study of diffusion characteristics of streams, c) the effect of organic and inorganic stream solids on radioactivity concentration, and d) the effect of suspended sediment and river-bed material on the transportation of radionuclides.--Auth. (Courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 486, abs. 3769, Feb. 15, 1961).

**3-2829.** Kaufman, W.J. THE CONTAINMENT OF RADIOACTIVE WASTES IN DEEP GEOLOGIC FORMATIONS (In: Scientific Conference on the Disposal of Radioactive Wastes, Monaco, 1959. ... Proceedings: v. 2, p. 533-546, Vienna, 1960)

The disposal system employing deep formations of the earth is conceived to consist of a pattern of injection wells for introducing the waste, and of relief wells which serve to reduce well-head pressures, permit monitoring, and direct the flow in such a manner as to make maximum use of the formation. Information needed for the design of such a system includes data on the dispersion or short-circuiting properties of the formation, ion-exchange characteristics of the media, and the chemical and radiochemical properties of the waste. A 2-well prototype injection system is in operation at the Engineering Field Station of the University of California.--Auth. (courtesy Nuclear Science Abstracts, v. 15, no. 3, p. 486, abs. 3770, Feb. 15, 1961).

**3-2830.** Love, J. David, and Linn Hoover. A SUMMARY OF THE GEOLOGY OF SEDIMENTARY BASINS OF THE UNITED STATES, WITH REFERENCE TO THE DISPOSAL OF RADIOACTIVE WASTES: U.S. Geol. Survey, Trace Elements Inv. Rept. 768, 89 p., map and index (in pocket), May 1960, 294 refs.

A possible method of disposing of liquid radioactive wastes that result from the production of atomic energy is to inject them through wells into subsurface rock units in various sedimentary basins. To insure that this method of disposal is not hazardous, the physical characteristics of the proposed storage basins must be determined. Approximately 60 separate areas in the United States are considered as potential waste disposal sites, and their location, gross geologic features, and natural resources are summarized.--Auth.

**3-2831.** WILMINGTON SUBSIDENCE IS ENDING: Petroleum Week, v. 12, no. 11, p. 18, 20, illus., March 17, 1961.

Waterflooding has nearly licked the subsidence problem in California's Wilmington oil field, the second largest in production in the U.S. The program is so successful that, in the critical area of the Navy shipyard, the land has been lifted as much as 3 in. The maximum sinking rate is now slightly less than 0.5 ft. per year at the worst point. This compares to a high of 2.4 ft. a year in 1951.

In addition to halting subsidence, the waterflood program is proving to be a highly profitable operation. Estimates of recoverable oil in the field are climbing sharply - from a little over 1 billion barrels to nearly 1.5 billion barrels in the developed portion of the field.--C. C. McFall.

**3-2832.** Bouwkamp, J.G. BEHAVIOR OF WINDOW PANELS UNDER IN-PLANE FORCES: Seismol. Soc. America, Bull., v. 51, no. 1, p. 85-109, 16 figs., 4 tables, Jan. 1961.

This paper discusses the results of 39 in-plane loading tests on single window panels under a horizontal in-plane force applied to the horizontal top member of a steel, pin-connected, or hinged, loading frame. Under this load condition the movement of the glass with respect to the sash as well as the horizontal in-plane deflection, or drift, of the window panel, fastened to this hinged frame, were measured by means of dial gages.

The following variables were included: panel size and panel configuration, panel attachment to hinged frame, sash material, clearance between glass and sash, and hardness of putty.

Thirty-three specimens were tested under static loads. Two tests were performed under repeated reversed loads and 4 under impact loads.

Some conclusions were derived regarding the ultimate drift of a window panel under the load conditions used and as affected by the variables listed.--Auth.

**3-2833.** Kachadoorian, Reuben, and others. GEOLOGIC INVESTIGATIONS IN SUPPORT OF PROJECT CHARIOT, PHASE III, IN THE VICINITY OF CAPE THOMPSON, NORTHWESTERN ALASKA - PRELIMINARY REPORT: U.S. Geol. Survey, Trace Elements Inv. Rept. 779, 104 p., geol. map (in pocket), scale 1:125,000, 17 figs., 5 tables, Jan. 1961, refs.

The Chariot test site, at the mouth of Ogotoruk



Peak in the vicinity of Cape Thompson, Alaska, is geologically and topographically well situated for the location of several nuclear devices to create an experimental excavation proposed by the U. S. Atomic Energy Commission. Bedrock within a 15-mi. radius consists of marine consolidated clastic and chemical sediments of Early Mississippian to Cretaceous(?) age, and at least 23,700 ft. thick. The rocks crop out in N.-trending bands with the oldest on the W. side and progressively younger beds exposed from E. to E. The western half is dominated by imbricate thrust faults, along which sheets of limestone and dolomite of the Lisburne group of Mississippian age have been thrust eastward. Rocks in the eastern half are complexly folded and broken by high-angle faults. The structure was probably formed during the Laramide orogeny. The differences in structure between the 2 parts of the area probably reflect the difference in response to the deforming stresses by rocks of different competence. The Chariot test excavation is entirely in frozen mudstone which has been complexly folded and faulted. Locally, the rocks are overturned. The mudstone contains numerous fault planes, most of which are less than 5 ft. wide. The mudstone strikes N. 20°E., and dips from 80°W. to 70°E. Fracture cleavage is prominent throughout the mudstone. Three joint sets underlie the test site and dip at 20°, 45°, and 70°.

Moisture content of the rock ranges from 3.1 to 12.5%. The use of refrigerated diesel fuel as drilling fluid in 1960 overcame the collapse of drill-hole walls owing to thawing of permafrost experienced in drilling by conventional techniques in 1959.

The 1960 surf year for studying coastal processes began on July 5, when the pack ice left the shore, and ended on Oct. 21, when the beach became stabilized by the formation of a kaimoo (ice rampart) on its surface. Breakup of sea ice had no effect on beach sediments. Piston-core samples from lagoons which do not contain the mouths of rivers and streams show that only about 10 cm. of sediment have been laid down in the lagoons since the last major rise of sea level. Between 100,000 and 63,000 years ago, sea level in the area reached approximately 8 m. above its present stand; this was followed by 50,000 years during which the sea withdrew. Sea level rose again 15,000 years ago to 3 m. below its present position; subsequently it rose slowly, attaining its highest stand in the 19th century.

The 2 new holes (Charlie and Dog), drilled through permafrost, are providing much of the precise temperature information needed for a quantitative evaluation of the thermal regime of lower Ogotoruk Creek valley. The depth and temperature of permafrost are affected by the proximity of surface bodies of water, especially the sea, and of major irregularities in topographic relief. At a point 300 ft. inland, the bottom of permafrost (0°C. isotherm) is at a depth of 945 ft.; 4,000 ft. inland it extends to a depth of 1,170 ft. The thermal regime of permafrost is not in equilibrium with the present position of the shoreline or the present climate. If the present climate persists the permafrost will become thinner by about 300 ft. The thinning has not yet commenced, however, as the present climatic change has been in progress for only the past century. Independent of the climatic effect, if the present shoreline were in thermal equilibrium, an additional 300 ft. or so of permafrost would have been removed at points 300 ft. inland. An encroachment of the sea in the past 2,000 to 5,000 years is indicated by preliminary calculations based on the assumption that the transgression occurred abruptly in a single stage.

The flow of heat to the surface from the earth's interior is on the order of one millionth of a calorie per square centimeter of surface per second, close to the worldwide average, contrary to speculation that the Arctic is anomalous. Gravity measurements between Kotzebue and Point Hope indicate a broad uneven gravity low with double minimums near Cape Seppings and Kivalina, caused by thick Mesozoic sediments, similar to the gravity low associated with the Colville geosyncline S. of Point Barrow.

Shallow and deep aquifers exist in the Chariot test site area. The shallow aquifers, principally unconsolidated material, depend upon recharge during flood stages and are drained during low water. The deep aquifers are in permeable portions of bedrock and receive recharge water from distant sources. Any radioactive fallout in the Ogotoruk Creek drainage could contaminate the shallow alluvial aquifer of the creek; however, it appears that the aquifer is essentially depleted and replenished each year. Substantial radioactive fallout inland probably would contaminate the deep aquifers by recharge from snowmelt or rainwater percolating into the rocks. For all practical purposes, no flow occurred in Ogotoruk Creek from late Oct. 1959 to mid-May 1960. --M. Russell.

3-2834. U. S. Geological Survey. MILITARY GEOLOGY OF ISHIGAKI-SHIMA, RYŪKYŪ-RETTŌ. PART I. GENERAL DESCRIPTION OF THE TERRAIN. PART II. ENGINEERING ASPECTS OF THE TERRAIN. By Helen L. Foster, and others. Prepared under the direction of the Chief of Engineers, U. S. Army, by the Intelligence Division, Office of the Engineer, Headquarters U. S. Army Pacific, with personnel of the U. S. Geological Survey: 323 p., 6 figs. (1 in pocket), 77 pls. (incl. 7 maps in pocket), 30 tables (2 in pocket), [Washington, D. C.], 1960, 38 refs.

Ishigaki-shima has very complex terrain for an island only 86 sq. mi. in area. There are densely forested mountains over 500 m. (1,640 ft.) in elevation. There are highly dissected terraces and rocky terrain with comparatively little dissection. The lowlands are small in area and are mostly stream valleys or sandy coastal flats. They make up only about 10% of the island.

Oak forests dominate the mountain areas, but there are few large trees because of continued logging. Much of the terrace and rolling terrain area is cultivated as it has been for long periods of time; other parts of it are covered with harsh, coarse grasses. The wet lowlands, where suited, are used for cultivation of rice. Dry coastal flats are commonly covered by grass or littoral forests and thickets.

There are more than 15 main types of igneous, sedimentary, and metamorphic rocks, and each of these has many variations. The rocks range in age from Paleozoic to Recent, with at least 2 geologic eras represented. Mesozoic rocks have not been identified to date. The geologic structure is complex because of several different tectonic disturbances which metamorphosed, folded, and faulted the rocks.

The soils and their distribution are also complex. They are mapped as 29 different units. Although the total area of a soil unit may be large, individual occurrences of the soil commonly are small in area. The soils are both shallow and deep and of many different textures and compositions, all of which are classified in this report for application to both agricultural and engineering problems.

The wide variation in topography and the complexity of the rocks and soils leads to a diversity of conditions pertaining to military operations. Many cliffed coasts and the fringing reef limit the feasibility of large-scale amphibious operations. Mountainous, rocky, dissected, and much heavily vegetated terrain makes airborne operations hazardous. These same factors hamper cross-country move-

ment. Although most types of construction material are available, new road and airfield sites, especially of the specifications generally required, are limited or lacking. Sufficient water could be supplied to most sites but in many cases not without considerable expense and engineering effort. Sites for underground installations are available in the mountain areas.--Auth. synopsis.

## 15. MISCELLANEOUS

3-2835. Karrow, Paul F., comp. **BIBLIOGRAPHY OF THESES ON ONTARIO GEOLOGY (CAMBRIAN TO QUATERNARY INCLUSIVE)**: Ontario, Dept. Mines, 11 p., 1960.

This bibliography lists 154 theses on the post-Precambrian geology of Ontario completed before July 1959. The geology departments of 4 universities in southern Ontario were visited, and letters were sent to 27 other Canadian and United States universities. Additional titles were obtained from published sources.--Auth.

3-2836. Ginn, R. M., comp. **BIBLIOGRAPHY OF THESES ON THE PRECAMBRIAN GEOLOGY OF ONTARIO**: Ontario, Dept. Mines, Misc. Paper MP-2, 50 p., map, 1961.

This bibliography lists 502 theses on the Precambrian geology of Ontario completed before Sept. 1960. Letters were sent to 111 universities in Canada and the United States. Additional titles were obtained from published sources. A bibliography of theses on the post-Precambrian geology of Ontario was published in 1960 [see above].--Auth.

3-2837. Curtis, Neville M., Jr. **ANNOTATED BIBLIOGRAPHY AND INDEX OF OKLAHOMA GEOLOGY, 1960**: Oklahoma Geology Notes, v. 21, no. 3, p. 55-81, March 1961.

Includes approximately 300 items relative to Oklahoma geology appearing in professional and trade journals, government documents, foreign publications, etc., during the year 1960.--A. Nicholson.

3-2838. Montana, Bureau of Mines and Geology. **BIENNIAL REPORT... TO THE LEGISLATIVE ASSEMBLY, 1958-1960**: Its: Spec. Pub. 19, 15 p., map, 1960.

This report covers 2 fiscal years from July 1, 1958 through June 30, 1960. The report briefly describes the projects of the bureau. Under each of the divisions, Information Service, Geology, Mining, Metallurgy, and Petroleum, is a brief statement as to its aims, a summary of work done during the reporting period, and a closing statement as to future plans and needs. Appendices are included: a financial statement, statistics relating to duties of the bureau, roster of personnel, list of publications, and mineral production statistics.--U. M. Sahinen.

3-2839. [New York State Museum and Science Service, Geological Survey]. **GEOLOGICAL RESEARCH IN NEW YORK STATE, 1960**: Its: News Letter no. 12, 16 p., March 1961.

Individual geologic projects undertaken or continued during 1960 in New York are grouped under

various headings alphabetically by name of the research worker. Under Precambrian geology, 13 are noted; under general geology, including paleontology and stratigraphy, 36; under glacial geology, 8; under economic geology, 16; under geophysics and geochemistry, 10. Progress on the new State Geological Map is reported. The completed map should go to press in late 1961. Thirty-nine theses on New York geology are listed.--A. C. Sangree.

3-2840. Ohio, Dept. of Natural Resources. **ANNUAL REPORT, 1959-1960**: 91 p., illus., maps, graphs, tables, Columbus, 1960.

Includes reports of the Division of Geological Survey (p. 19-27), Division of Shore Erosion (p. 54-59), and Division of Water (p. 60-67).

3-2841. Texas, University, Bureau of Economic Geology. **REPORT FOR 1960**: [8] p., illus., table, Austin, [1961].

At the close of 1960 the Bureau completed its 52nd year. Publications during 1960 are noted. Projects initiated during the year include: 1) a mineral resource study of 36 S. Texas counties; 2) a study of occurrence of high-Ca limestone and silica sand along the outcrop of Comanchean rocks from the Red River to the Rio Grande; 3) mapping and correlation of volcanic rocks northwestward from Big Bend National Park into the Bofecillos Mountains of southern Presidio County; 4) preparation of a manuscript on Texas rocks and minerals. The most significant developments in the mineral industry (excluding oil and gas) were connected with U, Fe, barite, potash, S, talc, water, and cement. Staff news is given.--A. C. Sangree.

3-2842. Miller, John P. **GEOLOGY IN POLAND**: GeoTimes, v. 5, no. 8, p. 33-36, 2 maps, May-June 1961.

The author spent 30 days in Poland as a lecturer on geomorphology at geographical, geological, and soil science centers.

Polish geology is carrying on in the tradition of excellence for which it has long been noted. There is some direction from the State, but research is far more hampered by lack of equipment, libraries, and other facilities destroyed during the war than by restrictions on individual freedom. Despite these obstacles, important fundamental work is being done, and a well-trained corps of young scientists is developing.

The Geological Institute in Warsaw is the principal geological organization of the country. Its objectives are to work out a synthesis of the geological structure of Poland and to extend the national raw material base. In recent years its activities have been concentrated on exploration of buried bedrock structures



geophysical work and by numerous borings through the thick mantle of glacial drift that covers most of Poland.

The author praises the friendliness of the Poles and states that those who attend the International Association on Quaternary Research meetings in the fall of 1961, will find that Polish hospitality will offset the inconveniences that must be expected.--L. Foster.

2-2843. **PIONEER OCEANOGRAPHIC PROJECT:** Military Engineer, v. 52, no. 350, p. 491, map, Nov.-Dec. 1960.

The U. S. Coast and Geodetic Survey ship Pioneer has embarked on an oceanographic investigation covering an 8,000 sq. mi. section of the Pacific Ocean NW. of San Francisco. Studies will be made of bottom sediments, sea-water temperatures, salinities, currents, and magnetic disturbances. Current meters will transmit data from buoys to shipboard radio recorders. Also, parachute drogues will be suspended at depths of approximately 6 and 1,000 ft., secured by line to surface floats, and tracked for 48 hours while drifting with current. Detailed investigations will be made of the Vizcaino and Noyo sea valleys located 50 mi. offshore in depths of 7,800 ft.--A. C. Mason.

2-2844. McGirk, Lon S., Jr. **AZIMUTH WITHOUT TIME:** Am. Assoc. Petroleum Geologists, Bull., v. 45, no. 4, p. 550-556, 4 tables, Apr. 1961, 11 refs.

Two methods are given to determine azimuth from true N. without calculating astronomical time. The equal altitudes method is to observe by a transit or alidade the horizontal angle from a reference (azimuth) mark to any star E. of the meridian, then observing, some hours later, the horizontal angle when the same star reaches the identical altitude W. of the meridian, the meridian being the mean of the 2 directions. The other method, that of azimuth by altitude, consists of turning the angle from reference point to a known star well to the E. or W. and observing the direction and altitude of the star simultaneously. From the observed altitude and tabular data the astronomic azimuth of the star is computed which, combined with the horizontal angle from the reference mark to the star, gives the astronomic azimuth of the line from the observer to the reference mark.--F. E. Kottowski.

3-2845. **ORTHOPHOTOSCOPE:** Military Engineer, v. 52, no. 348, p. 316, July-Aug. 1960.

The universal orthophotoscope is an improved instrument to produce orthophotographs, which are uniform-scale photomaps that are free from image displacement due to camera tilt or topographic relief. Two overlapping aerial photographs are projected to form a 3-dimensional image on a moving screen with a small central slit through which light passes to strike photographic film. The operator views the images on the screen and causes the screen and film to raise or lower so that the slit skims the surface of the ground as it appears in the 3-dimensional image.--A. C. Mason.

3-2846. Viktorov, S. V. **A BRIEF HISTORICAL REVIEW AND THE PRESENT STATUS ON THE GEOBOTANICAL METHOD IN GEOLOGY.** Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3,

no. 5, p. 408-411, May 1961, 14 refs.

A review of the literature shows that the relation of plants to geologic and hydrologic conditions has been recognized for several centuries. The geobotanical method is well adapted to ground-water and ore searches, and relies heavily on interpretation of aerial photographs. Its use in general geologic mapping is increasing.--M. Russell.

3-2847. Vostokova, E. A., and G. I. Zhdanova. **UTILIZATION OF GEOBOTANICAL INDICATORS IN AEROGEOLOGIC MAPPING IN WESTERN KAZAKHSTAN.** Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 5, p. 412-416, May 1961, 2 refs.

Geobotanical methods were useful in geologic mapping of Cretaceous to Triassic rocks of the Temirsk and Aktyubinska regions of western Kazakhstan. Eleven vegetation assemblages helped distinguish lithology, salinity conditions, and geologic age.--M. Russell.

3-2848. Shvyryaeva, A. M. **AN EXPERIMENT ON THE APPLICATIONS OF GEOBOTANICAL GUIDES IN DISTINGUISHING BETWEEN LITHOLOGICALLY SIMILAR STRATA OF DIFFERENT ORIGIN.** Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 5, p. 417-426, 6 figs., May 1961, 8 refs.

Presents the techniques and the various steps followed in the utilization of geobotanical indicators for geologic mapping of areas E. of and adjacent to the Mugodzarskiye mountains. It was found that despite the apparent homogeneity of the plant cover on lithologically similar rocks, a geobotanical analysis reveals a number of fundamental differences. Even when the floristic composition of associations is the same, other differences are seen in quantitative ratios of species, in the occurrence of some species in the plant cover, and finally, in the development cycle of an association as a whole, or of its individual species. In many instances also considerable floristic differences are observed in the plant cover found on lithologically similar rocks. Differences in plant cover on lithologically similar formations result from the physical chemical properties of rocks, which in turn result from the origin of rocks, the conditions of their formation, and the depths of their occurrence. In utilizing geobotanical data for lithological mapping of great importance is the character of plants growing at the contacts of formations which emerge at the surface. The following regularly occurring characteristics were noted. a) Hydrophytes develop at the contacts of rocks of different lithologic composition when impermeable rocks underlie permeable and moderately permeable rocks (sandstone, marly sandstone). b) At the contact of rocks of a different lithologic composition, when water-impermeable rocks (clays) overlie water-permeable rocks (sand, sandstone, marly sandstone) vegetation quickly dries up because the overlying rocks are dry as a result of being separated from the ground water. c) A transitional zone of plants is observed at the contacts of lithologically similar rocks and makes possible the determination of the boundaries of these rocks. The boundaries may be very sharp if the lithologically similar rocks have a different type and amount of salinity.--M. Russell.

3-2849. Voronkova, L. F. UTILIZATION OF THE GEOBOTANICAL METHOD IN LITHOLOGIC MAPPING OF EARLY ALLUVIAL DEPOSITS. Translated by Gaida M. Hughes: *Internat. Geology Rev.*, v. 3, no. 5, p. 427-432, 4 figs., May 1961, 8 refs.

Analysis of plant cover is a useful tool in detecting lithologic distinctions in alluvial deposits. Application of the method in mapping the Kunya-Darya plain in Turkmenia is described. The genus *Haloxylon* is a sensitive indicator of lithology.--M. Russell. Russell.

3-2850. Betz, Frederick, Jr. THE GEOLOGICAL SOCIETY OF AMERICA: *GeoTimes*, v. 5, no. 8, p. 18-23, 46-47, 6 illus., port, May-June 1961.

The Geological Society of America, which will reach its 75th birthday in 1963, traces its lineage from the Association of American Geologists, founded in 1840 and forerunner of the American Association for the Advancement of Science. The foremost contributions of the Society are its publications. These include its monthly *Bulletin*, its *Memoirs*, *Special Papers*, the *Treatise on Invertebrate Paleontology*, the *Bibliography and Index of Geology Exclusive of North America*, and various other volumes, pamphlets, guidebooks, and maps. Other major functions of the Society are its Annual Meetings (and Regional Section Meetings), and financial support for research.

The Society is governed by a Council of 17 Fellows. Its business is conducted mainly through its headquarters, which is administered by the Secretary. It maintains close relationships with several associated societies and is itself an affiliate of the American Association for the Advancement of Science.

The Society awards the Penrose Medal, the Day Medal, the Kirk Bryan Award, and the honorary rank of Correspondent for those not resident in North America.

The present membership, including Fellows and Members, is 4,816. The salient points of Membership and Fellowship are summarized in order to encourage those who have meant to seek Membership or Fellowship to do so.--G. L. Foster.

3-2851. Lindquist, Clarence B. GEOLOGY DEGREES DURING THE DECADE OF THE FIFTIES: *GeoTimes*, v. 5, no. 8, p. 15-17, 3 tables, May-June 1961.

During the decade of the 1950's, the number of bachelor's degrees in geology declined from a high of 3,043 in the year ending 1950, to 1,632 in the year ending June 1954, and then rose steadily again to 2,816 in the year ending June 1959. The percentages of geology degrees among all bachelor's degrees were higher in the later years (0.762 of 1% in 1958). A total of 23,298 bachelor's degrees in geology were awarded during the period. The number of master's degrees remained steady, with a high of 700 conferred in the year ending June 1958. Only 3.7% of the bachelor's degrees in geology, 3.1% of the master's and 2.1% of the doctorates were conferred upon women. Fifty-four institutions awarded doctorates in geology during the 10-year period.--G. L. Foster.

3-2852. PENDULUM SWINGING TOO FAR? 1960-61 STUDENT ENROLLMENT SURVEY: *GeoTimes*, v. 5, no. 8, p. 24-27, 3 graphs, 4 tables, May-June

1961, ref.

The preliminary report on 1960-1961 enrollment of geology-geophysics majors in undergraduate and graduate degree-granting departments in the United States and Canada. In Canadian schools a precipitous decline in junior enrollment has begun, and it seems probable that senior enrollment will drop in 1962. In the United States, the sharp decline of undergraduate majors at the junior and senior levels continues unabated. Master's enrollments continued downward, and Ph.D. programs had a slightly increased enrollment.

If enrollment trends in the United States continue in 1962 undergraduate majors will equal enrollment in the Master's program and almost equal enrollment in the Ph.D. programs. The undergraduates being trained will constitute only about 6% of the geology-geophysics professions. A continuation of the decline in enrollments will pose serious problems for geologic departments and employers. On the other hand, a slow upturn could result in an improved over-all academic level of the profession.--G. L. Foster.

3-2853. Shedd, A. Neal, and others. CAREERS IN ENGINEERING, MATHEMATICS, SCIENCE AND RELATED FIELDS; A SELECTED BIBLIOGRAPHY: U.S. Dept. Health, Education, & Welfare, Office Education, OE-26007, Bull. 1961, no. 8, 39 p., Washington, D.C., U.S. Govt. Print. Off., 1961.

This bibliography of 385 briefly annotated references was designed to suggest sources from which counselors, teachers, secondary school students, and others concerned with vocational guidance decisions can obtain free and inexpensive career information. No attempt was made to separate technical from professional fields, although emphasis was placed on those requiring professional training. All publications included in the bibliography are available from the sources listed. Addresses and prices are given. Titles are listed under subdivisions of the following main categories: agriculture, biological sciences, engineering, forestry, health professions, mathematics, and physical sciences. Geography, geology, and geophysics are listed under physical sciences (p. 34-35).--A. C. Sangree.

3-2854. Halliday, William R. PROTECTION OF RAINBOW BRIDGE NATIONAL MONUMENT: *Science*, v. 133, no. 3464, p. 1572-1579, 4 illus., table, May 19, 1961, approx. 30 refs.; Reply by Angus M. Woodbury, p. 1579-1583, 3 illus., 2 graphs, 8 refs.

The filling of Glen Canyon reservoir will partially flood the canyon under Rainbow Bridge [Utah] at high water. At lower water levels deposits of silt will accumulate. The authors disagree on the effect of this intermittent flooding on the stability of the famous arch, the esthetic appearance of the silt accumulation, and the feasibility of building protective barriers across the Bridge Canyon.--F. P. Glasser.

3-2855. National Academy of Sciences-National Research Council, Space Science Board. SCIENCE IN SPACE. CHAPTER I. DIMENSIONS AND PROBLEMS: A GENERAL REVIEW: 41 p., 5 tables, Washington, D.C., 1961, 15 refs.

The introductory chapter of a 9-chapter report, each chapter issued, or to be issued, separately, having the general purpose of reviewing areas and



opportunities for important research studies using space vehicles and to suggest what now appear to be major areas of emphasis for the national space effort. This first chapter reviews the immediate background of space science activity, summarizes the current status of the national program, considers briefly and generally problems and challenges, and outlines the areas of international cooperation in this field. The succeeding 8 chapters for which this chapter provides the synthesis are as follows: 2) The nature of gravitation [GeoScience Abstracts 2-2040], 3) the earth [GeoScience Abstracts 2-2037], 4) the moon, 5) the planets, 6) the sun, 7) physics of fields and energetic particles in space, 8) galactic and extragalactic astronomy, and 9) the biological sciences and space research.--M. Russell.

3-2856. Lunar and Planetary Exploration Colloquium. PROCEEDINGS, SEPTEMBER 23-24, 1959: Its: v. 2, no. 1, 59 p., illus., secs., diags., graphs, [1960?]

This publication was prepared from tape recordings of the meeting of the Colloquium held at Space Technology Laboratories, Los Angeles, California, Sept. 23-24, 1959. It contains an introduction by S. M. Greenfield (p. 1); reports of the Astrobiology, Earth Sciences, and Astronomy Sessions (p. 2-48); and a recapitulation and appraisal of the meetings (p. 49-57). The Earth Sciences Session was chaired by W. W. Kellogg. The keynote speech by Jack Green and the discussions are given.--A. C. Sangree.

In answer to the question "what can geology do, here on the earth's surface, for the science of astronautics," there are 3 major areas of likely research. First we need more information about rocks and their behavior under environments other than those found on earth; secondly we could do theoretical studies of petrologic systems; and thirdly there needs to be improvement in interpretation of maps and photographs.

In geophysics, environmental chambers should be used to more advantage than they have been up to now, and they should be readily available to the earth scientists. We need to know more about the physical properties of rock dusts under lunar and space conditions, such as the shear strength, radiation effects, the sonic velocity, the density and the porosity. We should be very much concerned with the miniaturization of existing tools - the density log, the electrical

log, the nuclear magnetism log, the radioactivity log, the neutron log. Also many other bore-hole devices could be miniaturized and studied in environmental chambers.

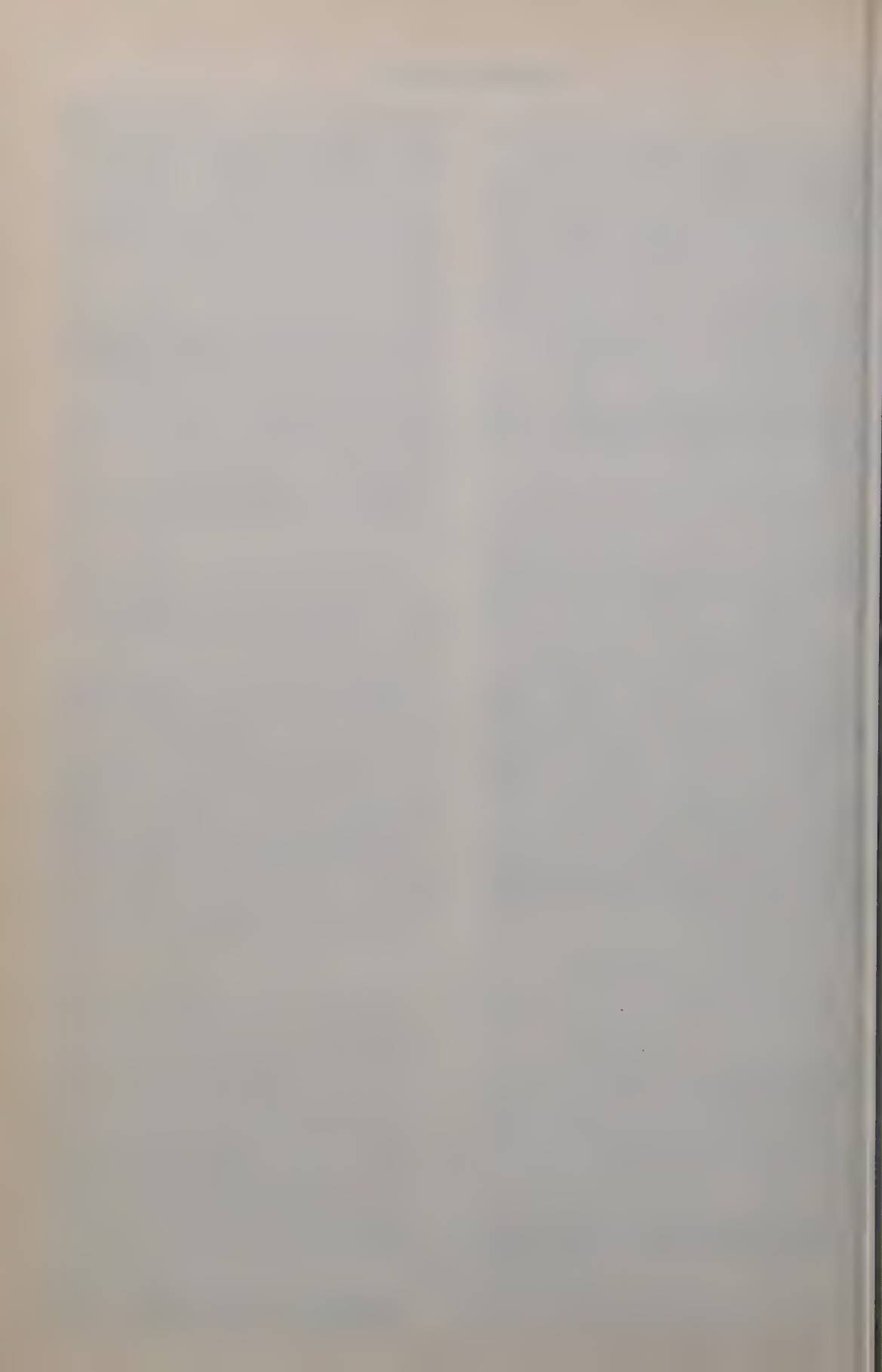
In geology the importance of the aerial photographs should be stressed. In addition we should continue field studies. There is a need for petrographic studies which relate to the genesis of hydrous rock types such as pitchstones and serpentines.

In geochemistry we should study the distribution of elements in volcanic extrusives and in chondrites, and in any other kind of material which might exist in space and on the cosmic bodies. There is a great data reduction problem in getting the correlation coefficients and other data that relate to the statistics of elemental distributions of these materials. These data are necessary to make good use of the raw materials that may be present on such cosmic bodies, particularly on the moon. The actual hardware requirements must be determined, and this is an extremely important factor that previously hasn't been brought out.

Because of the amount and nature of the work, interdisciplinary cooperation in space exploration is essential.--From E. M. Shoemaker and J. Green, p. 49-50.

3-2857. Alter, Dinsmore. EVOLUTION OF THE MOON: Lunar & Planetary Explor. Colloquium, Proc., v. 2, no. 2, p. 1-6, 3 figs., 3 tables, 1960, 5 refs.

One theory for the origin of the moon advanced by George Darwin postulates that at some time when the earth had the characteristics of a slightly compressible fluid, the moon was detached from the earth as the result of resonance tides set up during rapid rotation of the earth. Another theory, refined in 1949 by G. P. Kuiper, postulates the original existence of "protoplanets" much larger than the planets of today, within which there were smaller centers of condensation, the protosatellites. An old hypothesis lately revived postulates independent origins for both moon and earth, with the capture of the former by the latter as the result of accidental crossing of orbits. Points of argument pro and con for the different theories are summarized.--M. Russell.





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